

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SAMSUNG ELECTRONICS CO. LTD.,
SAMSUNG ELECTRONICS AMERICA, INC.,
SAMSUNG SEMICONDUCTOR, INC., and
SAMSUNG AUSTIN SEMICONDUCTOR, LLC
Petitioner

v.

CHIEN-MIN SUNG
Patent Owner

Case IPR2024- 00534

PETITION FOR *INTER PARTES* REVIEW OF
U.S. PATENT NO. 9,138,862
CHALLENGING CLAIMS 1-20
UNDER 35 U.S.C. § 312 AND 37 C.F.R. § 42.104

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PETITIONER’S EXHIBIT LIST

Petitioner Exhibit No.	DESCRIPTION
1001	U.S. Patent No. 9,138,862 (“’862 Patent”)
1002	Declaration of Dr. Stanley Shanfield
1003	File History of the ’862 Patent
1004	U.S. Patent Application Publication No. 2007/0060026 (“Sung’026”)
1005	“The Organic Diamond Disk (ODD) for dressing of Polishing Pads of Chemical Mechanical Planarization,” International Conference on Planarization / CMP Technology, 25-27 October 2007 (“SungICPT”)
1006	U.S. Patent Application Publication No. 2008/0087644 (“Nishioka”)
1007	International Patent Application Publication No. WO 2008/049019 (“Lin”)
1008	U.S. Patent Application Publication No. 2009/0001581 (“Kim”)
1009	U.S. Patent Application Publication No. 2009/0117692 (“Koyama”)
1010	U.S. Patent No. 5,036,015
1011	Ishizuka et al. “PCD Dressers for Chemical Mechanical Planarization with Uniform Polishing” Proceedings of International Conference on Leading Edge Manufacturing in 21 st Century: LEM21, 2007, Volume 2007.4
1012	U.S. Patent Application Publication No. 2008/0292869 (Sung’869)
1013	Fenna, Donald. “Hardness Numbers,” <i>A Dictionary of Weights, Measures, and Units</i> , 1st ed., Oxford University Press, 2004.
1014	Tsai et al., “Effect of CMP conditioner diamond shape on pad topography and oxide wafer performances,” <i>Int. J. Adv. Manuf. Technology</i> , 55: 253-262 (2011)
1015	Pysher et al. “Design, Characteristics and Performance of Diamond Pad Conditioners”, Materials Research Society Symposium Procedures, Vol. 1249, 2010 (“Pysher”)
1016	<i>Design, Characteristics and Performance of Diamond Pad Conditioners</i> . SpringerLink. https://link.springer.com/article/10.1557/PROC-1249-E02-04
1017	Exhibit 4 of Complaint in <i>Sung v. Samsung Electronics Co., Ltd. et al</i> , 4-23-cv-00752
1018	Scheduling Order in <i>Sung v. Samsung Electronics Co., Ltd. et al</i> , 4-

Petitioner Exhibit No.	DESCRIPTION
	23-cv-00752
1019	Electronic Copy of SungICPT obtained from IEEE, the publisher
1020	Records for <i>Proceedings ICPT 2007</i> available at https://search.worldcat.org/title/198200505 from WorldCat; at https://d-nb.info/985874066 (bibliographic record and MARC21-XML record) from the online catalog of the German National Library; and from OCLC FirstSearch (subscription required for access)
1021	TIB records for <i>Proceedings ICPT 2007</i> , available at https://search.worldcat.org/title/552588043 from WorldCat; at https://opac.tib.eu/DB=1/LNG=EN/CLK?IKT=12&TRM=585918058 from the classic catalog of TIB; at https://www.tib.eu/en/search/id/TIBKAT:585918058/Proceedings-ICPT-International-Conference-on-Planarization?cHash=aa6c9dc952dc92d0d78d53ec988dc7a5 from the TIB portal; and from OCLC FirstSearch (subscription required for access)
1022	Program and Invitation, ICPT International Conference on Planarization/CMP Technology, October 25 – 27, 2007, Hilton Hotel, Dresden, Germany, available at https://www.yumpu.com/en/document/read/19588721/program-and-invitation-eusar
1023	ICPT 2007 Conference Registration website, archived by Internet Archive on October 13, 2007, available at https://web.archive.org/web/20071013155043/http://icpt2007.com/Conferences_en/ICPT+2007/Conference+Registration/ from Internet Archive
1024	ICPT 2007 Program order form webpage, archive by Internet Archive on November 3, 2007, available at https://web.archive.org/web/20071103025949/http://icpt2007.com/Conferences_en/ICPT+2007/Conference+Program/Program+Order+Form.htm
1025	Online catalog of the German National Library archived on January 1, 2011 by Internet Archive, available at https://web.archive.org/web/20110101165839/www.d-nb.de/ from Internet Archive
1026	GetInfo Portal of the German National Library of Science and

Petition for *Inter Partes* Review of U.S. Patent No. 9,138,862
Claims 1-20

Petitioner Exhibit No.	DESCRIPTION
	Technology (TIB), archived on October 22, 2007 by the Internet Archive, available at https://web.archive.org/web/20071022114354/http://www.tib-hannover.de/en/getinfo-portal/ from Internet Archive
1027	Declaration of Dr. Ingrid Hsieh-Yee

Samsung Electronics Co., Ltd., Samsung Electronics America, Inc., Samsung Semiconductor, Inc., and Samsung Austin Semiconductor, LLC, collectively the “Petitioner,” requests *inter partes* review of claims 1-20 of U.S. Patent No. 9,138,862 (the “’862 Patent”) (EX1001).

I. Mandatory Notices

A. Real Parties-In-Interest

Petitioner identifies itself as a real party-in-interest (“RPI”).

B. Related Matters

Petitioner is concurrently filing petitions for *inter partes* review of U.S. Patent Nos. 8,974,270 and 9,724,802. The ’862 Patent is currently asserted against Petitioner by Patent Owner in *Sung v. Samsung Electronics Co., et al.*, No. 4:23-cv-752 (EDTX).

C. Counsel

Petitioner is filing a Power of Attorney appointing the practitioners associated with Customer Number 132,593. Petitioner designates the following lead and back-up counsels:

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II. Fees

Petitioner is concurrently electronically submitting the required fees for this Petition. The Board is authorized to charge Desmarais LLP's deposit account, No. 50-6822, for any fee deficiency.

III. Certification Of Grounds For Standing

Petitioner certifies that the '862 Patent is available for *inter partes* review and that Petitioner is not estopped or barred from requesting this *inter partes* review.

IV. Identification Of Challenge And Relief Requested

Petitioner requests *inter partes* review and cancellation of claims 1-20 of the '862 Patent.

A. Identification Of Prior Art

The following references are pertinent to the grounds of unpatentability explained below:

1. U.S. Patent Application Publication No. 2007/0060026 ("Sung'026") (EX1004), published on March 15, 2007, is prior art under 35 U.S.C. §102(b).¹
2. "The Organic Diamond Disk (ODD) for dressing of Polishing Pads of Chemical Mechanical Planarization," International Conference on Planarization / CMP Technology, 25-27 October 2007 ("SungICPT") (EX1005), published at least since September 28, 2007, is prior art under 35 U.S.C. §102(b).
3. U.S. Patent Application Publication No. 2008/0087644 ("Nishioka") (EX1006), published on April 17, 2008, is prior art under 35 U.S.C. §102(b).

¹ The actual filing date of the '862 Patent is March 13, 2013. This Petition applies the pre-AIA provisions of 35 U.S.C. §§ 102 and 103.

4. International Patent Application Publication WO 2008/049019 (“Lin”) (EX1007), published on April 24, 2008, is prior art under 35 U.S.C. §102(b).

5. U.S. Patent Application Publication No. 2009/0001581 (“Kim”) (EX1008), published on January 1, 2009, is prior art under 35 U.S.C. §102(b).

6. U.S. Patent Application Publication No. 2009/0117692 (“Koyama”) (EX1009), published on May 7, 2009, is prior art under 35 U.S.C. §102(b).

1. Public Accessibility of SungICPT

SungICPT was first published on September 28, 2007, in “International Conference on Planarization/CMP Technology.” While the conference was held on October 25-27, 2007, in Dresden, Germany, (EX1005, header), SungICPT was first cataloged by the German National Library and made available to the public as of September 28, 2007. EX1027, ¶¶41-70.

Specifically, the German National Library cataloged the conference proceedings containing SungICPT into OCLC on September 28, 2007. Therefore, as of September 28, 2007, users of WorldCat, the free web portal, and subscribers of OCLC FirstSearch would have been able to discover this conference proceedings, such as by searching its title, editor, related organizations, ISBNs, subject keywords, DDC numbers, and subject groups. EX1027, ¶¶42-49.

Additionally, German National Library of Science and Technology (TIB) cataloged the conference proceedings containing SungICPT into the WorldCat

database on November 27, 2008. EX1021. Therefore, users of WorldCat, the free web portal, and subscribers of OCLC FirstSearch would have been able to discover this conference proceedings as of November 27, 2008 by searching its title, editor, related organizations, ISBNs, subject keywords, DDC numbers, and subject groups. EX1027, ¶¶50-55.

Furthermore, the Program and Invitation of the ICPT 2007 Conference, which was archived on October 13, 2007, is further evidence of its public availability. EX1027, ¶¶56-63. Prior art obtained via the Wayback Machine® sets forth a *prima facie* case that the art was publicly accessible at the date and time provided in the time stamp. *See Valve Corp. v. Ironburg Inventions Ltd.*, 8 F.4th 1364, 1374-75 (Fed. Cir. 2021) (finding that reliance on Wayback Machine “is highly persuasive evidence of public accessibility ... by that date”); *see also* MPEP §2128.II.E (instructing the examiners that “[p]rior art obtained via the Wayback machine sets forth a *prima facie* case that the art was publicly accessible at the date and time provided in the time stamp”). The Program and Invitation of the ICPT 2007 Conference shows that a copy of the conference proceedings and a CD-ROM was provided to people who paid a conference registration fee. EX1022, EX1027, ¶57. The Proceedings and the CD-ROM were also available for sale at the conference. EX1022, p. 26. EX1027, ¶57. *See Kyocera Wireless Corp. v. Int’l Trade Comm’n*, 545 F.3d 1340, 1351 (Fed. Cir. 2008) (finding public accessibility when the

reference was contained in a book sold to the public).

For at least these reasons, SungICPT was “disseminated or otherwise made available to the extent that persons interested and ordinarily skilled in the subject matter or art, exercising reasonable diligence, [could] locate it” more than a year before the claimed priority date of the ’862 Patent. *In re Wyer*, 655 F.2d 221, 210 (CCPA 1981); MPEP §2128.I.

B. Statutory Grounds Of Unpatentability

Petitioner requests cancellation of claims 1-20 of the ’862 Patent under 35 U.S.C. § 102 and § 103² based on the following Grounds.

Ground	35 U.S.C.	Claims	Prior Art Reference(s) Relied Upon
I	§102/§103	1-6, 9-12, 20	Sung’026
II	§103	5-10	Sung’026 with SungICPT
III	§103	13, 17-19	Sung’026 with Nishioka
IV	§103	14	Sung’026 with Lin
V	§103	15	Sung’026 with Kim
VI	§103	16	Sung’026 with Koyama

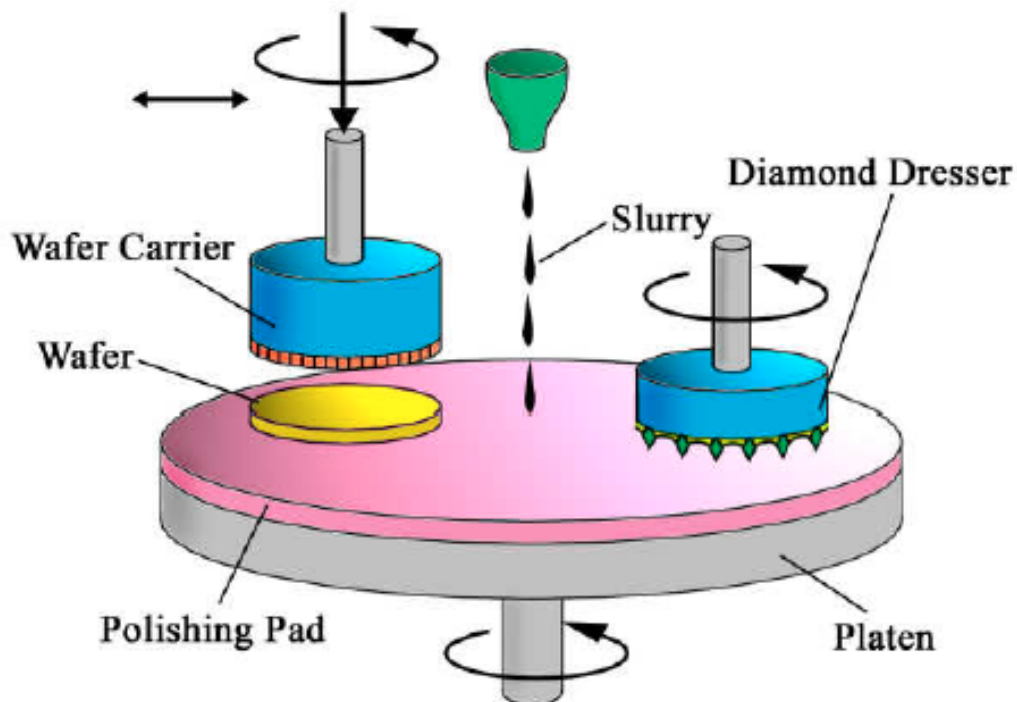
This Petition demonstrates that there is a reasonable likelihood that Petitioner would prevail with respect to at least one of the challenged claims. *See* 35 U.S.C. § 314(a).

² Petitioner reserves the right to challenge the patentability of the claims under 35 U.S.C. §112 in other proceedings.

V. Technology Background

A. Chemical Mechanical Planarization (CMP)

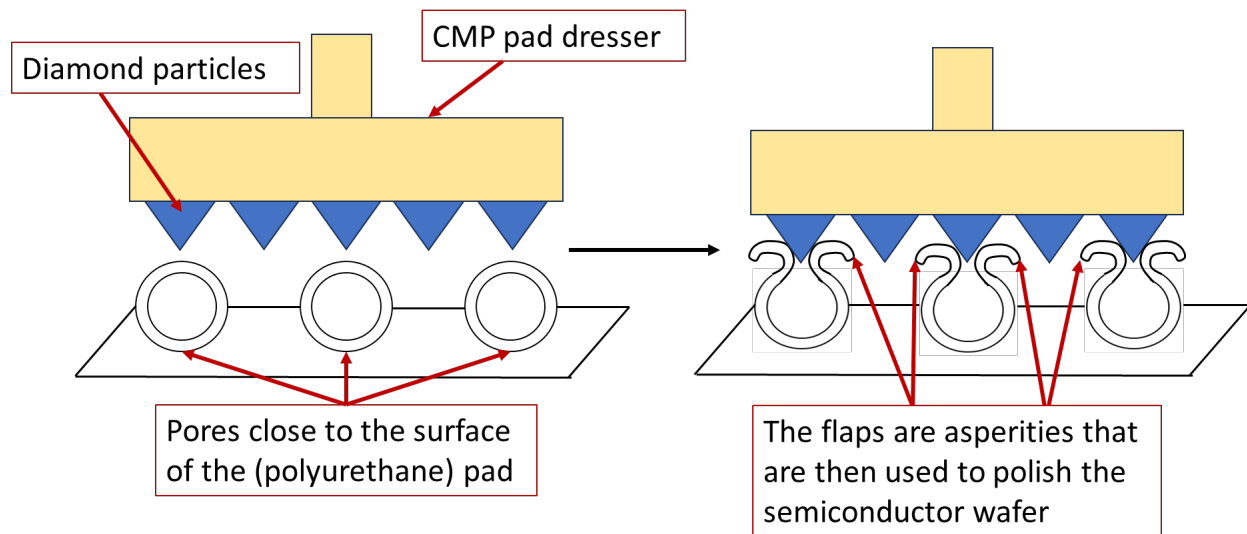
Chemical mechanical planarization (“CMP”) is a process that has been used in semiconductor manufacturing since about the 1990s to make semiconductor wafer surfaces planar. As the name implies, CMP includes both a chemical and a mechanical aspect. As shown below, a chemical slurry is applied to a CMP pad (“polishing pad”) as the semiconductor wafer is mechanically pressed onto a rotating CMP pad to planarize the semiconductor wafer.



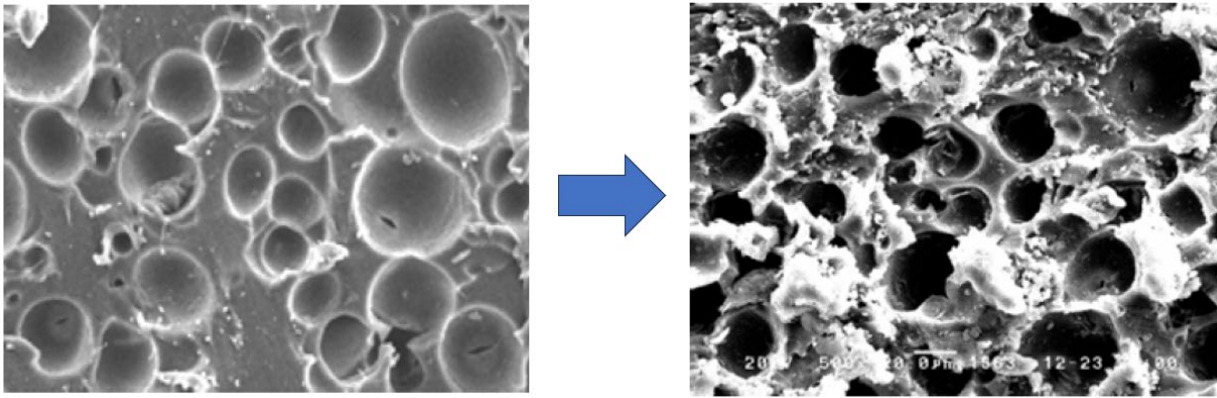
EX1011, Fig. 2; *see also id.*, 1:17-28; EX1010, 1:13-48. The rotating polishing pad is typically made of a soft polymeric material, such as polyurethane. EX1010, 1:44-

46; EX1011, 1:17-18. The polishing pad contains micron-sized asperities that can hold the slurry and polish the wafer. However, during use, the pad's polishing performance decreases as the asperities become dulled, and the pad must be reconditioned to regenerate the asperities for optimal performance. EX1004, [0004]. EX1002, ¶¶37-39.

A CMP pad dresser (labeled above as “diamond dresser” and also often called a “pad conditioner”) is used to “revive” the pad surface by “combing” or “cutting” the surface of the CMP pads using superabrasive particles, such as diamond particles. EX1004, [0004]. The diamond particles protruding from the dresser's substrate cut into the CMP pad and generate new asperities. EX1002, ¶40

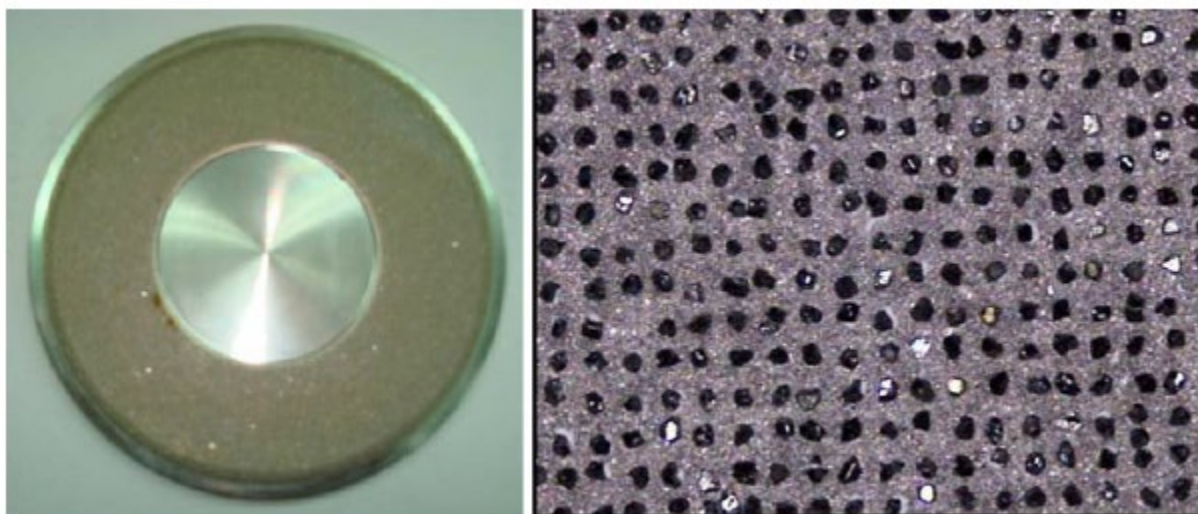


For example, microscope images of a new CMP pad (left) and one that has been conditioned for 20 hours by a CMP pad dresser is shown further below.



EX1014, Fig. 14. EX1002, ¶¶40-41.

A typical CMP pad dresser is shown below. As shown, the diamond particles are arranged over a portion of a circular disk. In this particular example, the diamond spacing is about 500 μm distributed over a portion of a 108 mm diameter disk (non-shiny portion), providing approximately 12,000 diamond particles. See EX1014, 255 (“The conventional diamond pad conditioner used—a DiaGrid (DG) disk (Kinik, Taiwan)—contained single-crystal diamond grits (120 μm). The diameter of the DG disk was 108 mm, with a diamond spacing (cutting pitch) of 500 μm and a single type of diamond grits across the entire disk, as shown in Fig. 3”), 258 (“DG contained approximately 12,000 diamond grits...”).



EX1014, Fig. 3 (“Appearance of conventional diamond disk”). EX1002, ¶¶42-44.

Various techniques to achieve a uniform protrusion of the diamond particles over the entire substrate surface have been developed in the art. For example, in 2007, Sung presented a paper (“SungICPT”) in a conference proceeding to discuss CMP pad dressers that he called “The Organic Diamond Disk (ODD) for Dressing Polishing Pads of Chemical Mechanical Planarization” that was made “by reversing the diamond attaching process ... with an organic matrix (e.g., epoxy).” EX1005, 1:30-2:1. This so-called “reverse casting” process entailed the following steps: (1) “[t]he diamond grits are first leveled to a mold surface” (2) “they are cast by covering with a polymer,” and (3) removing the mold to expose the diamond particles. EX1005, 2:1-2, Fig. 3 (showing diamond particles exposed over the epoxy matrix). The CMP pad dresser made in this manner is shown below.

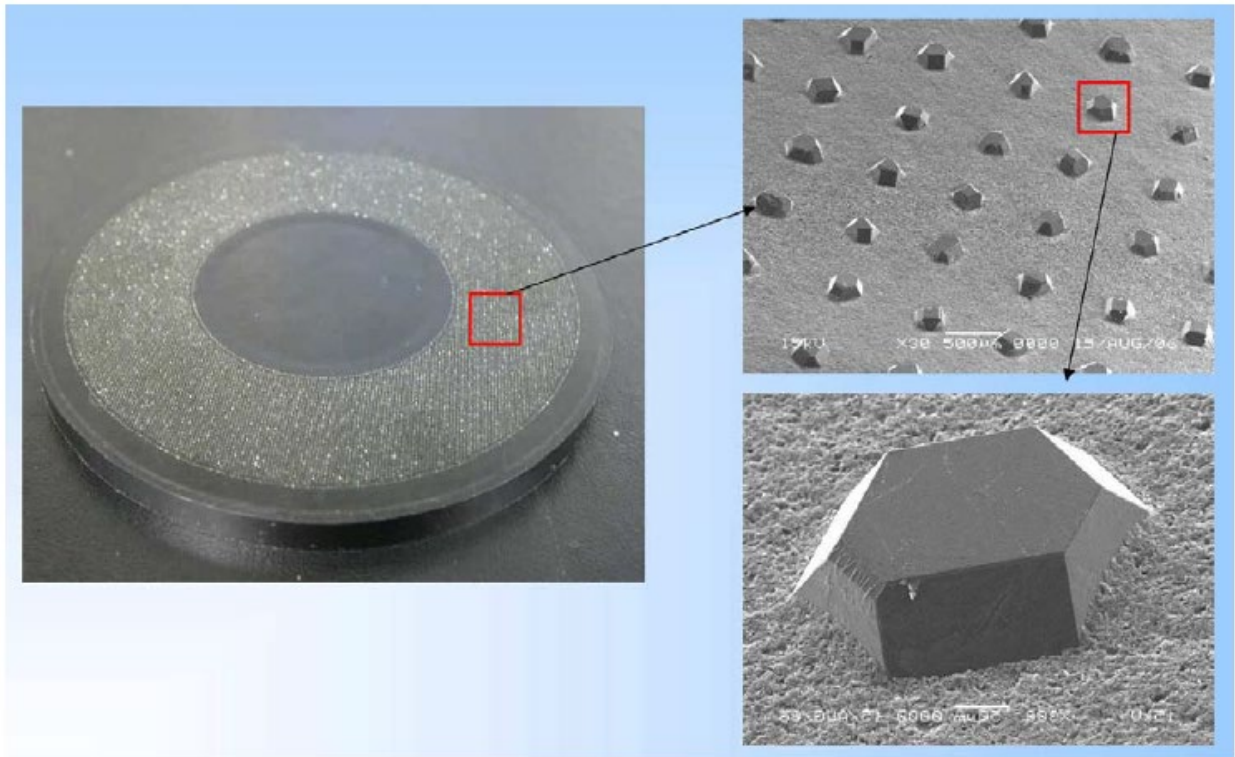


Fig. 3: The bonding conditions of diamond in the epoxy matrix.

EX1005, Fig. 3. Sung explained that “[d]ue to the pre-leveling of the diamond tips, their height variation is within 20 microns.” EX1005, 2:2-3. In other words, by controlling the degree of “pre-leveling” in the process, different degrees of leveling were readily available. EX1002, ¶¶45-47.

Regardless, CMP pad dressers with substantially level tips were well-known in the art. For example, Pysher (EX1015), published on August 1, 2010 (EX1016), shows a two-dimensional surface profile of two CMP pad dressers in its Figures 4a-4b, reproduced below. EX1015, 5, Fig. 4. Figure 4 of 1015 “compares two-dimensional surface profiles of” two conditioners where each point of the disk is below 50 μ m. EX1015, Fig. 4, 3:40-43. In fact, in the district court litigation against

Petitioner, Patent Owner acknowledged that Pysher meets limitation [1C] of claim 1: “wherein the difference in protrusion distance between the highest protruding tip and the second highest protruding tip of the monolayer of superabrasive particles is less than or equal to about 10 microns and the difference in protrusion distance between the highest 10 protruding tips of the monolayer of superabrasive particles are within about 20 microns or less” *See* EX1017, 8-17; EX1001, claim 1.

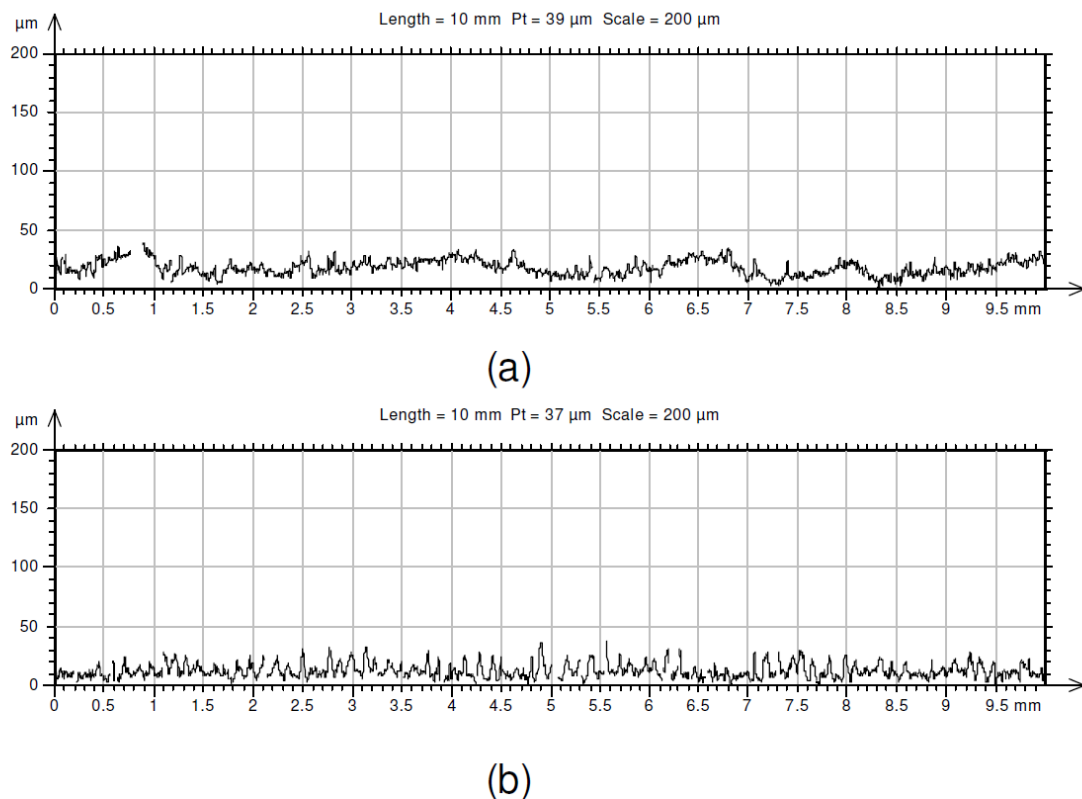


Figure 4. Surface profiles showing flatness of a) current and b) improved fine-finish disk designs.

EX1015, Fig. 4. EX1002, ¶¶48-49.

VI. Overview Of The '862 Patent

A. Earliest Claimed Priority Date

The '862 Patent is a continuation-in-part of U.S. Patent Application No. 13/479,148, filed on May 23, 2012, which in turn claims priority to U.S. Provisional Application No. 61/489,074, filed on May 23, 2011. For the purposes of this IPR only, Petitioner applies the earliest claimed priority date of May 23, 2011.

B. Purported Invention Of The '862 Patent

The '862 Patent is directed to methods of conditioning CMP pads using abrasive tools having superabrasive particles. *See* EX1001, Abstract. In particular, the '862 Patent notes that superabrasive tools, such as CMP pad dressers, should have substantially leveled tips to create asperities with a certain maximum cutting depth. *See* EX1001, 9:33-44, (“Thus, the relative leveling of the monolayer of superabrasive particles can greatly affect the morphology and distribution of asperities cut into the CMP pad by the dresser. For example, in one aspect, the monolayer is leveled such that rotating the dresser against the CMP cuts asperities having a maximum cutting depth of about 80 microns ... 60 microns ... [or] 40 microns.”). EX1002, ¶¶50-51.

The '862 Patent's specification notes that such leveling of the tips in a CMP pad dresser can be accomplished by using a “reverse casting” method. EX1001, 17:8-15 (“[S]o-called ‘reverse casting’ methods can be used to accurately orient and

attach the dressing segments to the rigid support.”). First, the superabrasive particles are secured “to a substrate using a ‘mask’ material.” *Id.* 17:10-12. Then, the superabrasive particles not covered by the masking material are “attached to the rigid support.” *Id.*, 17:12-14. For example, organic matrix materials, such as epoxy, can be used as the rigid support. *Id.* 17:16-57. Finally, “the masking material can be removed” “to accurately orient and attach the dressing segments to the rigid support.” *Id.*, 17:14-15, 17:8-10. EX1002, ¶52.

The claims recite what would result from such “reverse casting” process by including limitations such as “wherein the difference in protrusion distance *between the highest protruding tip and the second highest protruding tip* of the monolayer of superabrasive particles is less than or equal to about 10 microns and the difference in protrusion distance *between the highest 10 protruding tips* of the monolayer of superabrasive particles are within about 20 microns or less.” EX1001, claim 1 (emphases added). EX1002, ¶52.

But notably, as more fully explained below, the same “reverse casting” process was already disclosed in Sung’026—an application that was filed more than five years and published more than four years prior to the ’862 patent’s earliest claimed priority date. EX1002, ¶¶63-70.

C. Prosecution History Of The ’862 Patent

The application for the ’862 Patent, which included original claims 1-20, was

filed on March 13, 2013. *See* EX1001, Cover; EX1003, 4, 39-41. EX1002, ¶¶53-55.

On November 6, 2014, the Examiner issued a Non-Final Office Action rejecting claims 1-20 under 35 U.S.C. §103 over U.S. 2010/0248595 (“Dinh-Ngoc”) and U.S. 2008/0292869 (“Sung’869”), neither of which are relied on in this Petition. *See* EX1003, 892. For the limitations “the difference in protrusion distance between the highest 10 protruding tips of the monolayer of superabrasive particles are within about 20 microns or less; and rotating the dresser against the CMP pad such that asperities are cut into the CMP pad having a maximum cutting depth of about 60 microns,” the Examiner found that paragraphs [0010] and [0057]-[0059] of Sung’869 teach these limitations. *Id.* In particular, paragraph [0010] of Sung’869 is directed to the disclosure that superabrasive particles protruding to a predetermined height can produce certain cutting depths. For the other remaining claims, the Examiner additionally relied on paragraphs [0002], [0061] and [0062] of Sung’869. *See* EX1003, 893-895. EX1002, ¶¶56-57.

In response, Applicant, without amending the claims, argued that the disclosure of a cutting depth does not necessarily teach that the highest 10 protruding tips are within about 20 microns or less. *See* EX1003, 1185 (“Examiner argues that Sung[’869] discloses that superabrasive particles protruding to a predetermined height produce a cutting depth of less than 20 microns, and infers that this recitation

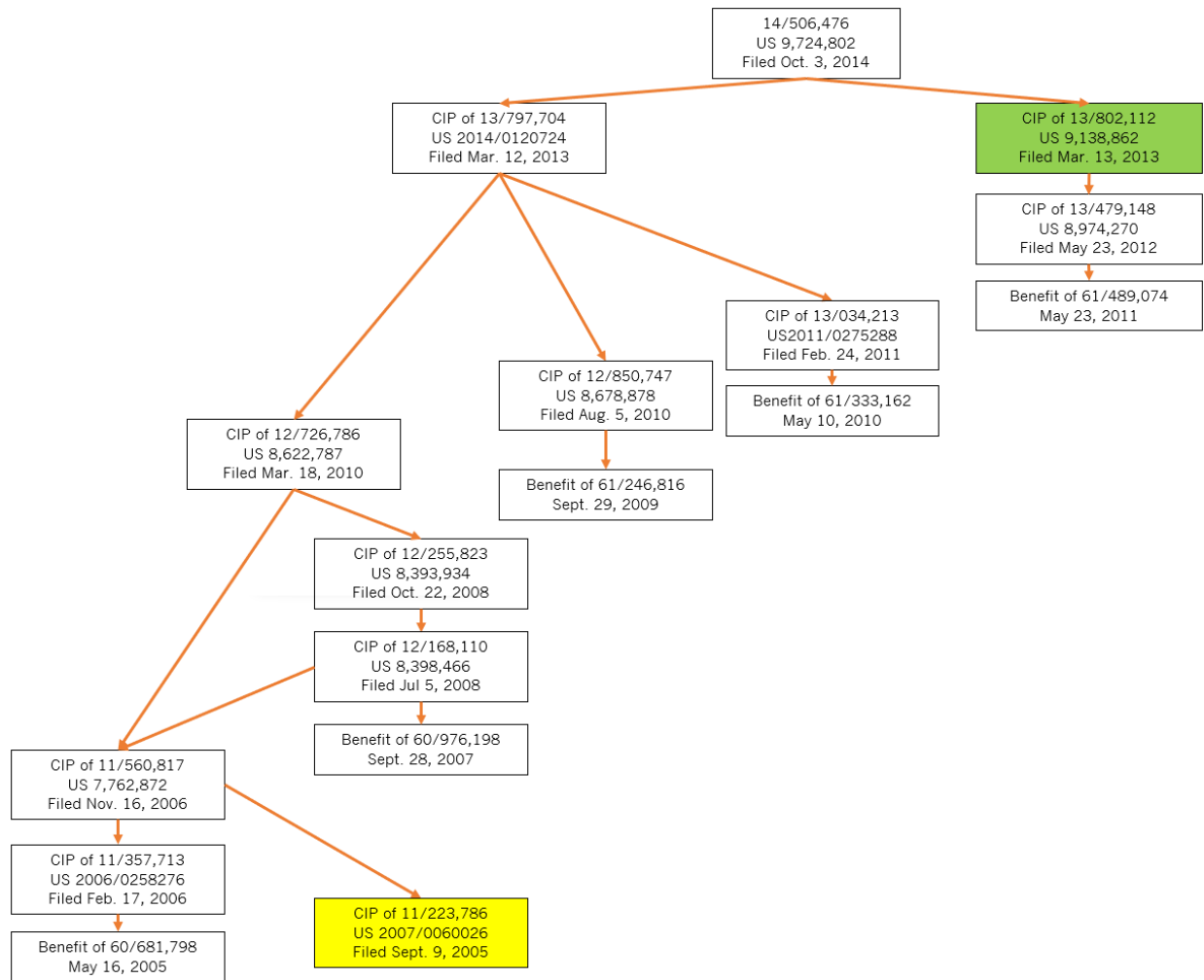
of cutting depth reads on the claim limitation that the highest 10 protruding tips are within about 20 microns or less. It is noted, however, that the depth to which a particle cuts into a deformable substance like a CMP pad is not necessarily a teaching of a protrusion distance of that particle.”); *see also id.*, 1182-1187. EX1002, ¶58.

Subsequently, on May 15, 2015, the Examiner issued a Notice of Allowance allowing all claims 1-20. EX1003, 1195-1199. The '862 Patent was issued on September 22, 2015. *See* EX1001, Cover; EX1003, 1270. EX1002, ¶59.

VII. Overview Of Sung'026 And SungICPT

The '862 Patent (highlighted in green below) is a parent application of U.S. Patent No. 9,724,802, which in turn claims priority to a large number of earlier filed applications dating all the way back to May 16, 2005. The '862 Patent does *not* claim priority to any of these other applications on the left side of the figure. Moreover, a number of these applications were published more than a year before the earliest claimed priority date of May 23, 2011, including Sung'026 (highlighted in yellow). SungICPT (not shown below) was also published more than a year before the earliest claimed priority date. Both Sung'026 and SungICPT are relied upon in this Petition.

Petition for *Inter Partes* Review of U.S. Patent No. 9,138,862
Claims 1-20



Briefly, both Sung’026 and SungICPT already disclosed the same “reverse casting” process that the ’862 Patent alleges “can be used to accurately orient and attach the dressing segments to the rigid support.” EX1001, 17:8-10. Specifically, as more fully described below, both Sung’026 and SungICPT utilize the same “reverse casting” process described in the ’862 Patent to fabricate what SungICPT calls “organic diamond disk (ODD).” EX1004, [0083]; EX1005, 1:9-11, 2:4-6. In other words, the same embodiment that purportedly can be utilized to make the

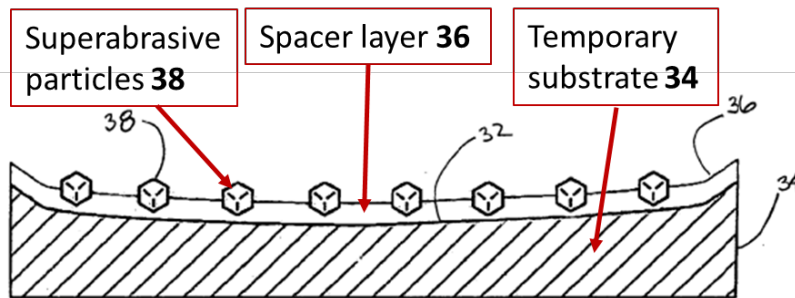
claimed CMP pad dressers was previously disclosed to the public by Sung more than a year before the earliest claimed priority date of the '862 Patent. EX1002, ¶¶63-73.

A. Sung'026

Sung'026 is directed to CMP pad dressers with superabrasive particles.³ EX1004, [0001], [0009] (“Accordingly, the present invention provides superabrasive tools and methods that are, without limitation, suitable to groom the CMP pads used for the delicate polishing applications as recited above.”). EX1002, ¶64.

Sung'026 teaches that “reverse casting methods may be utilized to manufacture the CMP pad dresser.” EX1004, [0083]. Specifically, as shown in Fig. 2 below and much like the '862 Patent, the superabrasive particles are first “disposed into a spacer layer.” *Id.*, [0084]; *see also* EX1001, 17:10-12 (“Such methods can include initially securing the plurality of dressing segments to a substrate using a ‘mask’ material.”).

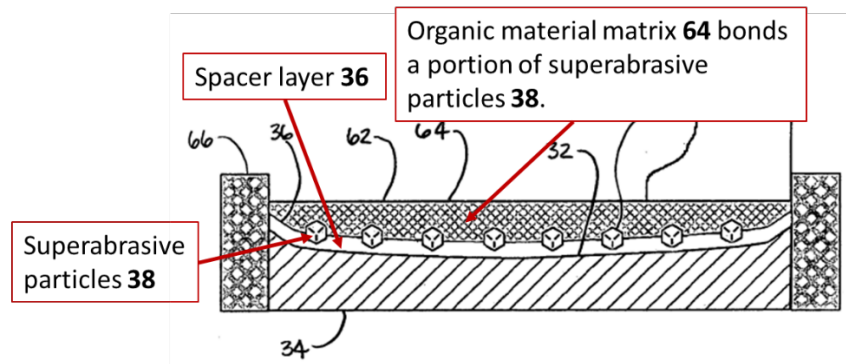
³ Sung'026 discloses that “‘particle’ and ‘grit’ may be used interchangeably, and when used in connection with a superabrasive material, refer to a particulate form of such material.” EX1004, [0033]. EX1002, ¶64.



EX1004, Fig. 2 (annotated). EX1002, ¶¶65-66.

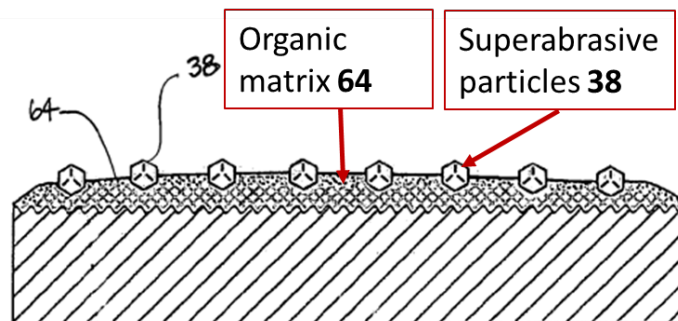
Then, an uncured organic material is applied to the spacer layer, and upon curing, the organic material matrix bonds⁴ “at least a portion of each superabrasive particle.” EX1004, [0087]; *see also* EX1001, 17:12-19 (“The portions of the dressing segments protruding from the mast material can then be attached to the rigid support.... When an organic material is utilized, methods of curing the organic material can be a variety of processes known to one skilled in the art that cause a phase transition in the organic material from at least a pliable state to at least a rigid state.”).

⁴ Sung’026 states that “‘organic material layer’ and ‘organic material matrix’ may be used interchangeably.” EX1004, [0030]. EX1002, ¶67.



EX1004, Fig. 5 (annotated). EX1002, ¶67.

Subsequently, the spacer layer is removed from the organic matrix. Thereby, the “distance of the protrusion of the superabrasive particles 38 from the organic material layer 64” is “approximately equal to the thickness of the now removed spacer layer,” as shown in Figure 6, below. EX1004, [0088]; *see also* EX1001, 17:14-15 (“[A]fter which (or during which), the masking material can be removed.”).



EX1004, Fig. 6 (annotated). EX1002, ¶68.

As such, Sung’026 teaches that the superabrasive particles can be arranged such that their tips vary from each other by less than about 2 microns. *See* EX1004, [0056] (“In yet another aspect, the plurality of superabrasive particles are arranged

such that their tips vary from the designated profile by less than about 1 microns.”), [0053], [0073]. Moreover, the superabrasive particles protrude a sufficient amount above the organic matrix **64** such that they can “produce a cutting depth of from about 1 micron to about 20 microns when used to abrade a work piece.” EX1004, [0010], [0052], claim 5. EX1002, ¶¶69-70.

B. SungICPT

SungICPT is also directed to “diamond pad conditioners [that] have markedly improved the leveling of diamond tips.” EX1005, 1:9-10. Like Sung’026, SungICPT teaches CMP pad dressers, which SungICPT calls “organic diamond disk (ODD),” made by “reverse casting.” *See id.* 1:9-11. Specifically, SungICPT explains that “[d]ue to pre-leveling of the diamond tips, their height variation is within 20 microns.” EX1005, 2:2-3. And “because the diamond tips are leveled to a much tighter range, the distribution of the dressing stress is much more uniform,” EX1005, 3:3-4, and “all diamond grits are sharing the dressing work.” EX1005, 1:11-14. EX1002, ¶72.

SungICPT shows images of the CMP pad dresser made using such reverse casting process. As shown, diamond particles are present in the peripheral part of the disk.

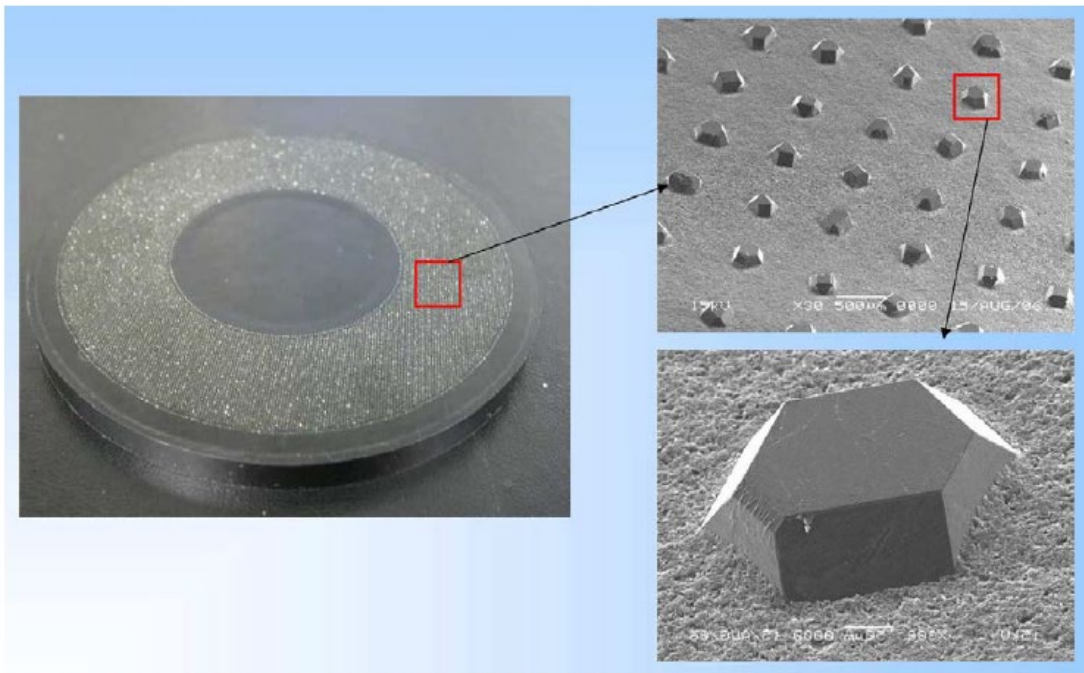


Fig. 3: The bonding conditions of diamond in the epoxy matrix.

EX1005, Fig. 3. EX1002, ¶73.

VIII. Level Of Ordinary Skill In The Art

A person having ordinary skill in the art (“POSITA”) would have had, as of the earliest claimed priority date of May 23, 2011, a bachelor’s degree in material science, mechanical engineering, electrical engineering, or physics, and a minimum of two to three years of experience in the field of integrated circuit processing and fabrication techniques. A higher level of education or specific skill might make up for less experience, and vice versa. EX1002, ¶¶60-62.

IX. Claim Construction

The claims should be construed “in accordance with the ordinary and customary meaning of such claim as understood by one of ordinary skill in the art

and the prosecution history pertaining to the patent.” 37 C.F.R. § 42.100(b); *see also Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005) (*en banc*). The Patent Owner can act as his own lexicographer. *See In re Paulsen*, 30 F.3d 1475, 1480 (Fed. Cir. 1994) (holding that an inventor may define specific terms used to describe the invention). Moreover, the Board “need[s] only construe terms ‘that are in controversy, and only to the extent necessary to resolve the controversy.’” *Nidec Motor Corp. v. Zhongshan Broad Ocean Motor, Co.*, 868 F.3d 1015, 1017 (Fed. Cir. 2017) (citing *Vivid Techs., Inc. v. Am. Sci. & Eng’g*, 200 F.3d 795, 803 (Fed. Cir. 1999)).⁵ While the Board may not need to construe the following terms for the purposes of this instant IPR proceeding, Patent Owner has acted as his own lexicographer for the following terms in the ’862 Patent.

A. “dresser”

Claims 1-10 recite “dresser.” The ’862 Patent notes that “[a]s used herein, the terms ‘conditioner’ and ‘dresser’ can be used interchangeably, and refer to a tool used to condition or dress a pad, such as a CMP pad.” EX1001, 3:9-11. EX1002, ¶76.

B. “superabrasive”

⁵ Petitioner reserves the right to raise other/additional claim construction arguments in any other/parallel proceedings.

Claims 1-5 and 9-10 recite “superabrasive.” The ’862 Patent notes that “[a]s used herein, ‘superabrasive’ may be used to refer to any crystalline, or polycrystalline material, or mixture of such materials which has a Moh[s] hardness of about 8 or greater.” EX1001, 3:32-34. Some examples of “[s]uch materials include ... diamond, polycrystalline diamond (PCD), ... as well as other superabrasive materials known to those skilled in the art.” EX1001, 3:36-40. EX1002, ¶77.

C. “particles”

Claims 1-5 and 9-10 recite “particles.” The ’862 Patent notes that “[a]s used herein, ‘particle’ is as used herein in connection with diamond particles, and refers to a particulate form of diamond.” EX1001, 3:66-4:1. EX1002, ¶78.

D. “protrusion”

Claim 1 recites “protrusion.” The ’862 Patent notes that “for the purposes of the present disclosure, the term ‘protrusion’ refers to the height of a particle relative to some reference point.” EX1001, 10:26-28. EX1002, ¶79.

E. “peripheral location”

Claims 5-10 recite “peripheral location.” The ’862 Patent notes that “[a]s used herein, ‘peripherally located,’ ‘peripheral location’ and the like, mean any particle of a dresser that is located in an area that originates at the leading edge or outer rim

of a dresser and extends inwardly towards the center for up to about 90% of the radius of the dresser.” EX1001, 4:30-39. EX1002, ¶80.

F. “substantially”

Claims 5, 9, and 10 recite “substantially.” The ’862 Patent notes that “[a]s used herein, the term “substantially” refers to the complete or nearly complete extent or degree of action, characteristic, property, state, structure, item, or result.” EX1001, 6:9-11. EX1002, ¶81.

G. “about”

Claims 1, 6-8, and 15 recite “about.” The ’862 Patent notes that “the term ‘about’ is used to provide flexibility to a numerical range endpoint by providing that a given value may be ‘a little above’ or ‘a little below’ the endpoint.” EX1001, 6:29-31. EX1002, ¶82.

X. Specific Grounds For Challenge

The sections below, as supported by Dr. Shanfield’s Declaration, demonstrate how the claims are unpatentable. 37 C.F.R. 42.104(b)(4)-(5).

A. Ground I: Sung’026 Anticipates And/Or Renders Obvious Claims 1-6, 9-12, And 20

1. Independent Claim 1

i. [1Pre] A method of conditioning a CMP pad, comprising

To the extent limiting, Sung’026 discloses [1Pre]. Sung’026 discloses

“superabrasive tools and methods that are, without limitation, suitable to groom the CMP pads used for the delicate polishing applications.” EX1004, [0009]. In particular, Sung’026 teaches that these superabrasive tools, *i.e.*, CMP pad dressers or conditioners, are used to revive the CMP pad surface. EX1004, [0004] (“CMP pad dresser can be used to revive the pad surface by “combing” or “cutting” it. This process is known as “dressing” or “conditioning” the CMP pad.”). EX1002, ¶¶85-86.

ii. [1A] pressing a CMP pad dresser against a CMP pad,

At the outset, as discussed in Section IX [Claim Construction], “dresser” means “a tool used to condition or dress a pad, such as a CMP pad.” EX1001, 3:9-11. Even assuming this is a lexicographic definition that must be applied, Sung’026 discloses limitation [1A]. EX1002, ¶88.

Sung’026 teaches “superabrasive tools and methods that are, without limitation, suitable to groom the CMP pads used for the delicate polishing applications.” EX1004, [0009]. For example, “FIG. 1 is a cross-sectional view of a CMP pad dresser.” EX1004, [0019].

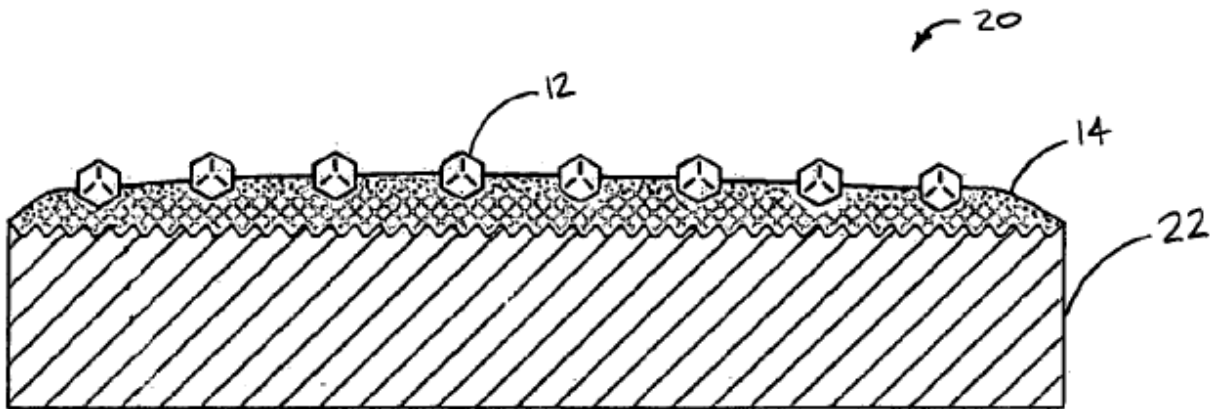


FIG. 1

EX1004, Fig. 1. EX1002, ¶89.

Sung’026 further teaches that CMP pad dresser is used to “revive the pad surface by ‘combing’ or ‘cutting’ it.” EX1004, [0004]. Furthermore, Sung’026 discusses that the superabrasive particles experience “mechanical stress” during abrasion of the work piece and proposes ways to distribute “frictional forces” across substantially each superabrasive particle to improve particle retention. EX1004, [0051] (“The method can include securing a plurality of superabrasive particles in the solidified organic material layer in an arrangement that minimizes mechanical stress impinging on the protruding portion of any individual superabrasive particle when used *to abrade a work piece*. ... in one aspect the arrangement of the plurality of superabrasive particles may be configured to *uniformly distribute frictional forces* across substantially each superabrasive particle.”), Abstract (emphasis

added). And because abrasion, friction, and pressures are achieved by pressing two objects against each other, Sung'026 teaches pressing a CMP pad dresser against a CMP pad. EX1002, ¶¶90-91.

iii. [1B] the dresser including a monolayer of a plurality of superabrasive particles protruding from a matrix layer,

At the outset, as discussed in Section IX [Claim Construction], “superabrasive” means “crystalline or polycrystalline material or mixture of such materials which has a Moh[s hardness of about 8.0 or greater,” and such materials include diamond. Additionally, as discussed in Section IX [Claim Construction], “particle” is used in the '862 Patent “in connection with diamond particles and refers to a particulate form of diamond.” Even assuming these are lexicographic definitions that must be applied, Sung'026 discloses limitation [1B]. EX1002, ¶93.

First, Sung'026 teaches CMP pad dressers having a single layer of superabrasive particles, which meets the claimed “monolayer of a plurality of superabrasive particles.” EX1004, [0074] (“One example of a tool incorporating a *single layer* of superabrasive particles in an organic material matrix is a *CMP pad dresser*.”), [0072] (“Tools may incorporate *a single layer* or multiple layers of superabrasive particles.”), [0001] (“The present invention relates generally to tools having superabrasive particles embedded in an organic material matrix and associated methods.”), [0099]. EX1002, ¶94.

Second, Sung’026 discloses that the superabrasive particles are diamond particles, which have a Mohs hardness of about 8.0 or greater. EX1004, [0016] (“For example, the plurality of superabrasive particles may include, without limitation, diamond, polycrystalline diamond...”), [0071] (“[T]he superabrasive particle may be diamond...”), [0094], [0096], [0098]-[0099], [0101]-[0104]; *see also* EX1001, 3:32-45; EX1013, 3 (showing a Mohs hardness of 10 for diamond). EX1002, ¶95.

Finally, Sung’026 discloses the plurality of diamond particles protruding from an organic matrix layer. EX1004, [0096] (“After hot pressing, the clay is scraped off, exposing the diamond particles protruding from the polyimide resin layer.”), [0010] (“[E]ach of the plurality of superabrasive particles may protrude to a predetermined height above the solidified organic material layer⁶,”), [0011], [0051]-[0053], [0056], [0073], [0076], [0077], [0083], [0088], [0090], [0092], claims 1, 3, 7, 13-15, 31, 36, 41, and 42. EX1002, ¶96.

⁶ The ’862 Patent notes that the terms “[o]rganic material layer’ and ‘organic matrix’ may be used interchangeably.” EX1001, 3:46-51.

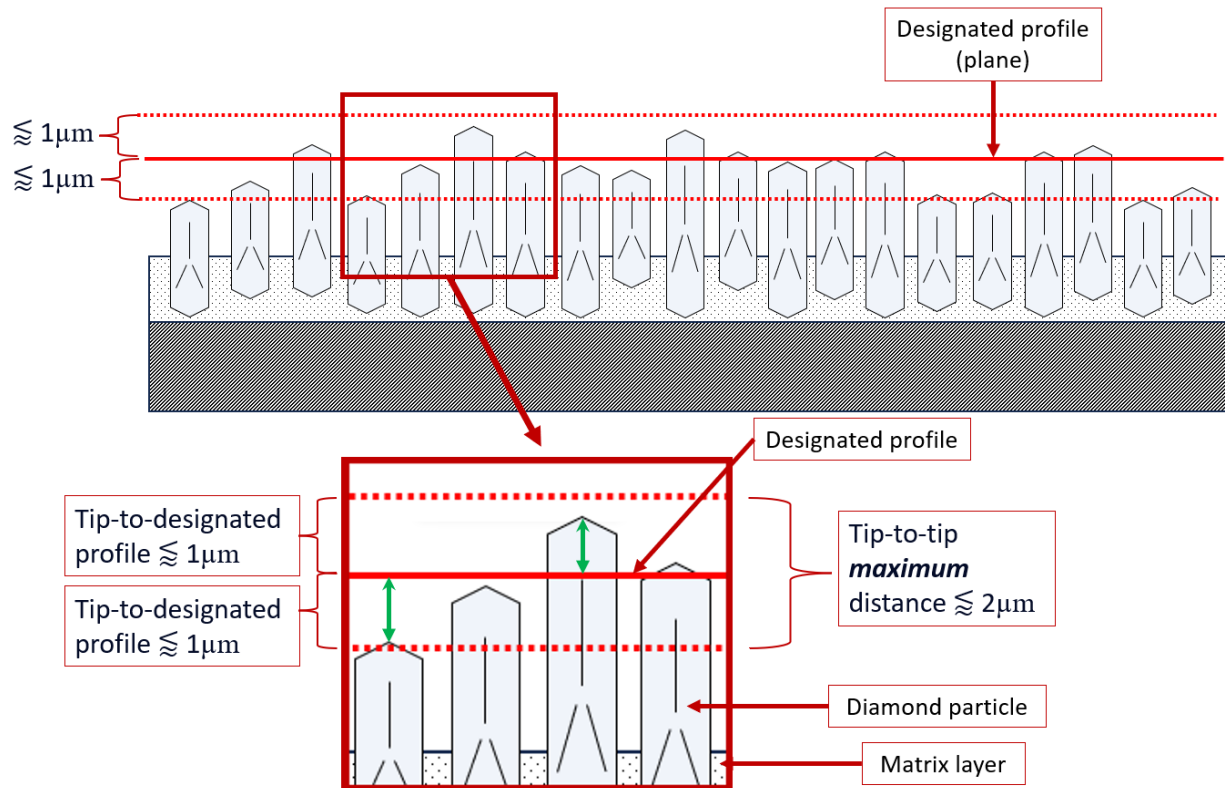
- iv. **[1C] wherein the difference in protrusion distance between the highest protruding tip and the second highest protruding tip of the monolayer of superabrasive particles is less than or equal to about 10 microns**

and the difference in protrusion distance between the highest 10 protruding tips of the monolayer of superabrasive particles are [sic] within about 20 microns or less; and

At the outset, as discussed in Section IX [Claim Construction], “protrusion” refers to “the height of a particle relative to some reference point.” Moreover, as discussed in Section IX [Claim Construction], “the term ‘about’ is used to provide flexibility to a numerical range endpoint by providing that a given value may be ‘a little above’ or ‘a little below’ the endpoint.” Even assuming these are lexicographic definitions that must be applied, Sung’026 discloses limitation [1C]. EX1002, ¶98.

Sung’026 discloses that “*each* of the plurality of superabrasive particles protrudes to a predetermined height above the solidified organic material layer.” EX1004, [0073], claim 31. More specifically, the particles protrude “along a designated profile,” where “the designated profile is a plane.” EX1004, claims 36 and 37; *see also id.*, [0053] (explaining that “[i]t may also be beneficial for the superabrasive particles to protrude from the solidified organic material layer to a predetermined height or series of heights that is/are along a designated profile. ... In one aspect, the designated profile may be a plane.”). In other words, Sung’026

teaches that every superabrasive particle has a height relative to the solidified organic material layer. The schematic illustrates the planar designated profile (red horizontal solid line) above the solidified organic matrix layer to which the superabrasive diamond particles protrude to a predetermined height. EX1002, ¶99.

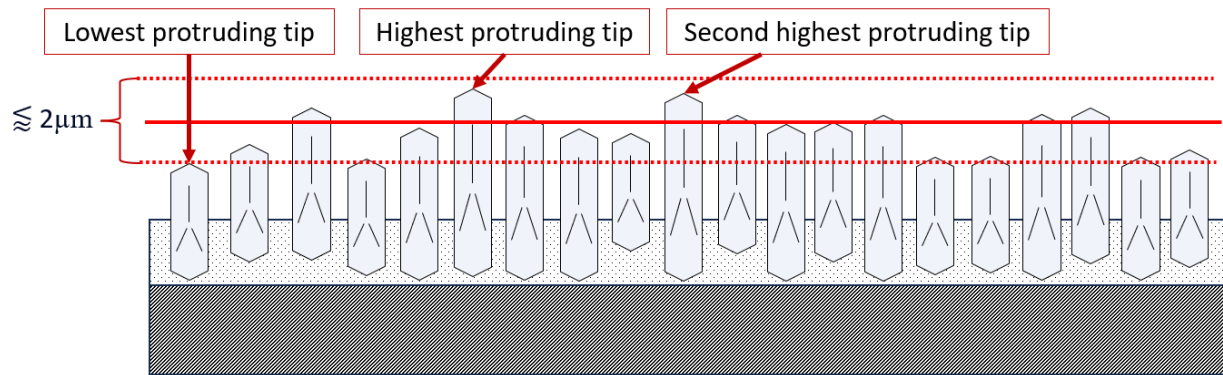


The schematic shows some deviations from the designated profile, because Sung’026 further explains that “[i]n planar profiles, the highest protruding points of the superabrasive particles are intended to be level. ... [A]lthough it is preferred that these points align with the designated profile, there may be some height deviation between superabrasive particles that occur due to limitations inherent in the manufacturing process.” EX1004, [0053]. Despite these limitations of the

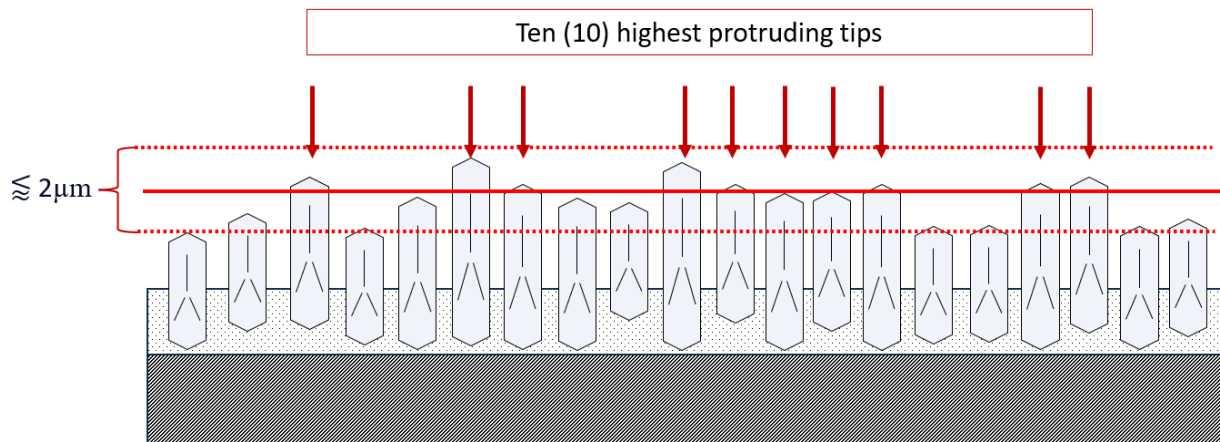
manufacturing process, Sung’026 discloses that “*the plurality of superabrasive particles is arranged such that their tips vary from the designated profile by less than about 1 microns.*” EX1004, [0056]; *see also id.*, [0073] (“For example, in one aspect *each* of the plurality of superabrasive particles may protrude to a predetermined height above the solidified organic material layer.”). EX1002, ¶¶100-102.

In other words, as schematically illustrated above, Sung’026 teaches that tip-to-designated profile variation is less than 1 micron for each of the superabrasive particles. EX1002, ¶103.

More specifically, because the tip-to-designated profile variation for each of the superabrasive diamond particles is less than 1 micron, the maximum tip-to-tip variation (*i.e.*, difference in protrusion distance between the highest protruding tip and the lowest protruding tip) is less than about 2 microns. Accordingly, the difference in protrusion distance between the highest protruding tip and the second highest protruding tip of the monolayer of superabrasive particles must also be less than 2 microns, which is within the claimed “less than or equal to about 10 microns.”



And because the tip-to-tip variation for each of the superabrasive diamond particles is less than 2 microns, the difference in protrusion distance between the highest 10 protruding tips of the monolayer of superabrasive particles must also be less than 2 microns, which is within the claimed “about 20 microns or less.” EX1002, ¶¶104-105.



This disclosure of Sung’026 anticipates limitation [1C] because “when, as by a recitation of ranges or otherwise, a claim covers several compositions, the claim is

‘anticipated’ if one of them is in the prior art.” *Titanium Metals Corp. v. Banner*, 778 F.2d 775 (Fed. Cir. 1985).⁷ EX1002, ¶106.

To the extent Patent Owner asserts that Sung’026 does not explicitly disclose limitation [1C], a POSITA would have found it obvious to control the difference in protrusion distances in the manner claimed in limitation [1C] in light of the teachings of Sung’026. Indeed, a POSITA would have found it obvious to try to obtain a leveled diamond particles that control the difference in protrusion distance between the highest set of protruding tips, including the highest, second highest, and the highest 10 protruding tips to be within the claimed range. The claimed ranges are what would result as part of Sung’026/’862 Patent’s efforts to provide leveled

⁷ But to be clear, this disclosure of Sung’026 would not provide written description support for limitation [1C] because it merely discloses a species within the more broadly claimed genus. *See Vas-Cath Inc. v. Mahurkar*, 935 F.2d 1555, 1562 (Fed. Cir. 1991) (“The difference between ‘claim-supporting disclosures’ and ‘claim-anticipating disclosures’ was dispositive ... ‘the description of a single embodiment of broadly claimed subject matter constitutes a description of the invention for anticipation purposes..., whereas the same information in a specification might not alone be enough to provide a description of that invention for purposes of adequate disclosure. ...’”).

diamond particles using a reverse casting process because it was well-known that there are numerous disadvantages associated with unlevelled tips. EX1002, ¶107.

For example, Sung’026 explains that “the particle tip height must be precisely leveled in order to uniformly dress the pad. Traditional CMP pad dressers can have particle tip height variations of more than 50 μm ... However, such a variation would render a dresser useless if it were required to dress a CMP pad and achieve a uniform asperity depth of 20 μm or less, for example.” EX1004, [0006]. Indeed, Sung’026 explains that “the highest protruding points of the superabrasive particles are intended to be substantially level.” EX1004, [0053]. And Sung’026 explains that a tip-to-tip variation of less than 2 μm is possible as well. *See* EX1004, [0056], [0073]. Hence, a POSITA would have been motivated to achieve tip height variations that are small to improve performance in the manner taught by Sung’026, such as by using a “reverse casting” process—a technique that the ’862 Patent itself explains as a suitable embodiment. EX1004, [0083] (“Various reverse casting methods may be utilized to manufacture the CMP pad dresser...”); EX1001, 17:8-15 (“[S]o-called ‘reverse casting’ methods can be used to accurately orient and attach the dressing segments to the rigid support.”). And a POSITA would have been able to achieve the difference in protrusion distances between the highest, second highest, and the highest 10 protruding tips in the manner claimed in limitation [1C] with a reasonable expectation of success because Sung’026 describes the same reverse casting process

that the '862 Patent contemplates. And Sung'026 teaches that it was within the POSITA's knowledge that tip-to-tip variation across all diamond particles can be controlled to be less than 2 μm using the reverse casting process, rendering it at a minimum obvious to provide similar level of tip variation between the highest, second highest, and the highest 10 protruding tips. EX1002, ¶¶107-108.

v. [1D] rotating the dresser against the CMP pad such that asperities are cut into the CMP pad having a maximum cutting depth of about 60 microns.

Sung'026 discloses limitation [1D]. Sung'026 teaches CMP pad dresser is a rotating tool. *See* EX1004, [0057] (“[I]n the case circumferentially *rotating tools* such as CMP pad dressers, superabrasive particles located near the periphery will most likely experience greater frictional force...”), [0012], [0054]. Sung'026 further teaches that such dressers are rotated against the CMP pad. *See* EX1004, [0004] (“A CMP pad dresser can be used to revive the pad surface... This process is known as ‘dressing’ or ‘conditioning’ the CMP pad.”). EX1002, ¶¶109-110.

Sung'026 teaches that “pad dressers ... cut asperities in the pad.” EX1004, [0005]; *see also id.*, [0004], [0006]. More specifically, Sung'026 explains that “*each* of the plurality of superabrasive particles may protrude to a predetermined height above the solidified organic material layer ... [and] the predetermined height may produce a cutting depth of from about 10 micron[s] to about 20 microns when used to abrade a work piece.” EX1004, [0010], [0052], claims 4-6. *See Titanium Metals*

Corp. v. Banner, 778 F.2d 775, (Fed. Cir. 1985) (explaining that “when, as by a recitation of ranges or otherwise, a claim covers several compositions, the claim is ‘anticipated’ if one of them is in the prior art.”). EX1002, ¶111.

2. Dependent Claims 2-4

- i. [2] The method of claim 1, wherein at least 100 tips of the plurality of superabrasive particles cut asperities into the CMP pad as the dresser is rotated.

[3] The method of claim 1, wherein at least 50 tips of the plurality of superabrasive particles cut asperities into the CMP pad as the dresser is rotated.

[4] The method of claim 1, wherein at least 25 tips of the plurality of superabrasive particles cut asperities into the CMP pad as the dresser is rotated.

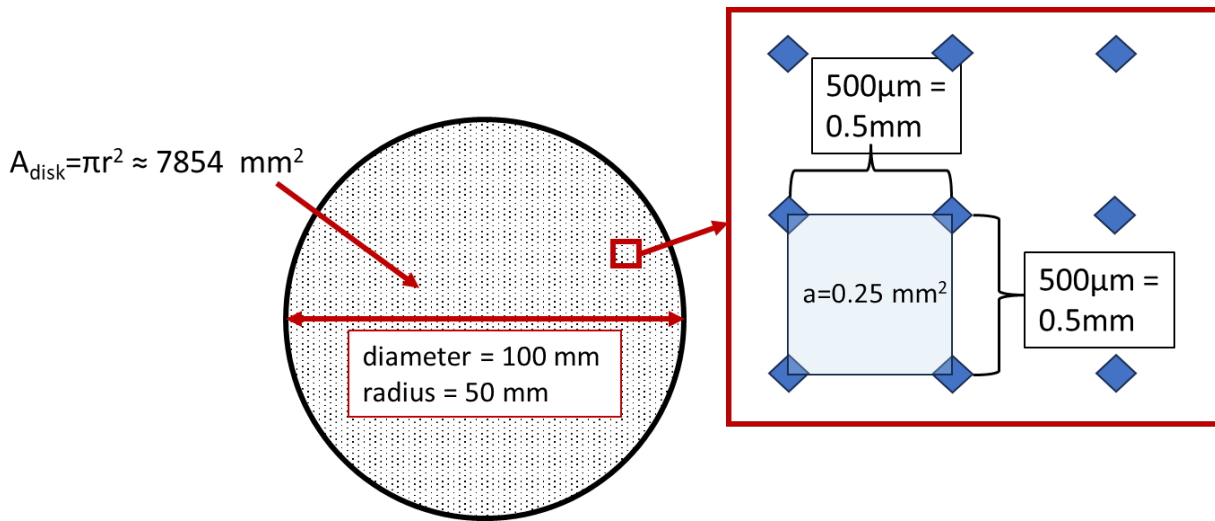
Sung’026 discloses the added limitations of [2]-[4]. *First*, as discussed in Section X.A.1.v [1D], Sung’026 discloses using CMP pad dressers in which “*each* of the plurality of superabrasive particles may protrude to a predetermined height above the solidified organic material layer ... [to] produce a cutting depth of from about 10 micron[s] to about 20 microns when used to abrade a work piece” as the dresser is rotated. EX1004, [0010]. Sung’026 further explains that Sung’026’s “arrangement of the plurality of superabrasive particles may be configured to uniformly distribute frictional forces across substantially *each* superabrasive particle[, and that s]uch a uniform distribution of frictional force prevents any individual superabrasive particle from being overstressed and pulling out of the

solidified organic material layer.” EX1004, [0051]; *see also id.*, [0075], claim 2. In other words, because each of the superabrasive particles cut to produce asperities and experience frictional forces, substantially all of the superabrasive particles are contributing to cutting asperities. *See also* EX1005, 1:12-13 (further affirming that “*all* diamond grits are sharing the dressing work” in ODD made by the same reverse casting process). EX1002, ¶¶112-113, 115.

At a minimum, Sung’026 discloses that “a *majority* of the plurality of superabrasive particles may protrude to a predetermined height above the solidified organic material layer” and that such “predetermined height may produce a cutting depth of from about 1 micron to about 20 microns when used to abrade a work piece.” EX1004, [0052]; *see also id.* [0076] (“The protruding superabrasive particles 12 can cut into the CMP pad to a depth that is essentially the distance of the protrusion.”), claims 3-6. EX1002, ¶114.

Second, while Sung’026 does not provide the exact number of superabrasive particles that are present on the CMP pad dresser, Sung’026 provides an example where the superabrasive particles are arranged onto a 100 mm diameter substrate in a grid having a diamond-to-diamond spacing of about 500 microns. EX1004, [0094] (“80/90 mesh diamond particles ... are arranged with a template on a 100 mm diameter, 10 mm thick flat base plate. The diamond particles form a grid pattern with an inter-diamond pitch of about 500 microns ... The final product is a pad

conditioner with uniformly exposed diamonds.”), [0040] (“As used herein, ‘grid’ means a pattern of lines forming multiple squares.”). An inter-diamond spacing of about 500 microns in a square pattern means the pad dresser includes about 1 diamond grit per about 0.25 mm². The total area of the disk with a diameter of 100mm is about 7,854 mm².⁸ Accordingly, about $7854/0.25 = 31,416$ **diamond particles** that cut asperities into the CMP pad are present on the CMP pad dresser.



⁸ The area of the diamond disk can be calculated using a formula for the area of the circle, which is $A=\pi r^2$, where r is the radius of the disk, *i.e.*, $\frac{1}{2}$ of the diameter.

The calculated area using this formula is about 7,854 mm². EX1002, ¶117.

$$A_{pad} = \pi r^2 = \pi \left(\frac{100}{2} \text{ mm} \right)^2 = 7,854 \text{ mm}^2$$

$$\frac{1 \text{ particle}}{(\text{particle spacing})^2} \times (A_{pad}) =$$

$$\frac{1 \text{ particle}}{0.5 \text{ mm} \times 0.5 \text{ mm}} (7,854 \text{ mm}^2) =$$

31,416 particles

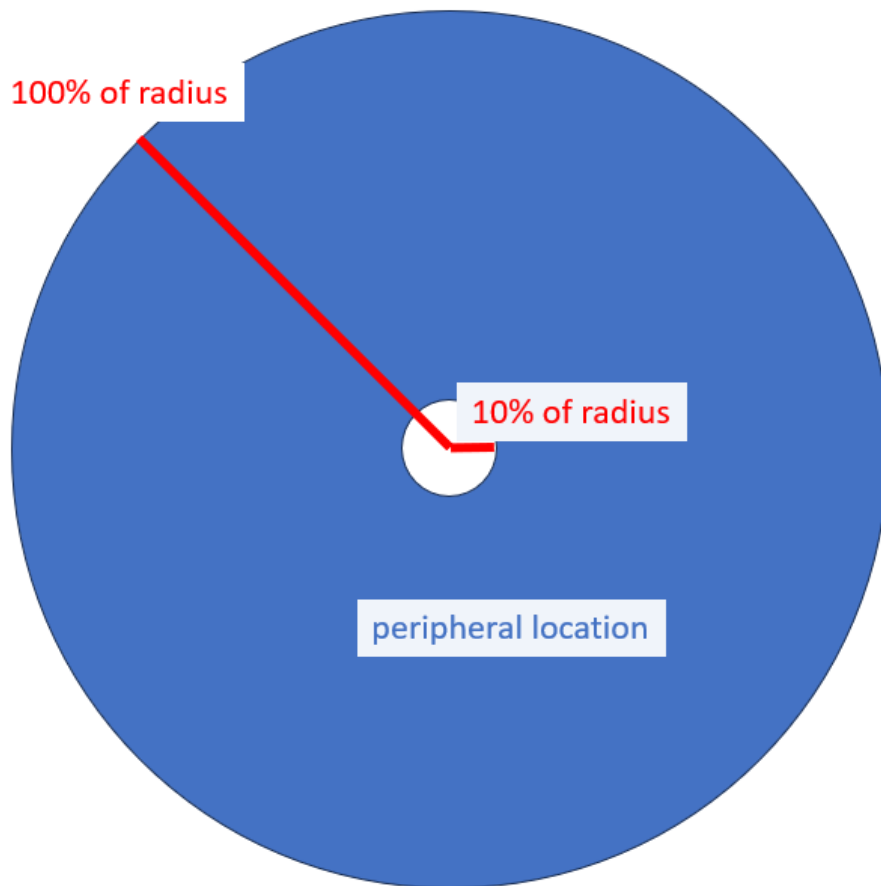
At a minimum, more than half (i.e., “majority” which is about **15,708 diamond particles**) contribute to cutting asperities into the CMP pad. Either way, the total number of particles having tips that cut asperities into the CMP pad as the dresser is rotated is many orders of magnitude larger than the claimed 25, 50, and 100 tips of claims 2-4. EX1002, ¶116-120.

3. Dependent Claim 9

- i. [9] The method of claim 1, wherein substantially all of the superabrasive particles are located at a peripheral location of the dresser.

At the outset, as discussed in Section IX [Claim Construction], the term “substantially” refers to the complete or nearly complete extent or degree of action,

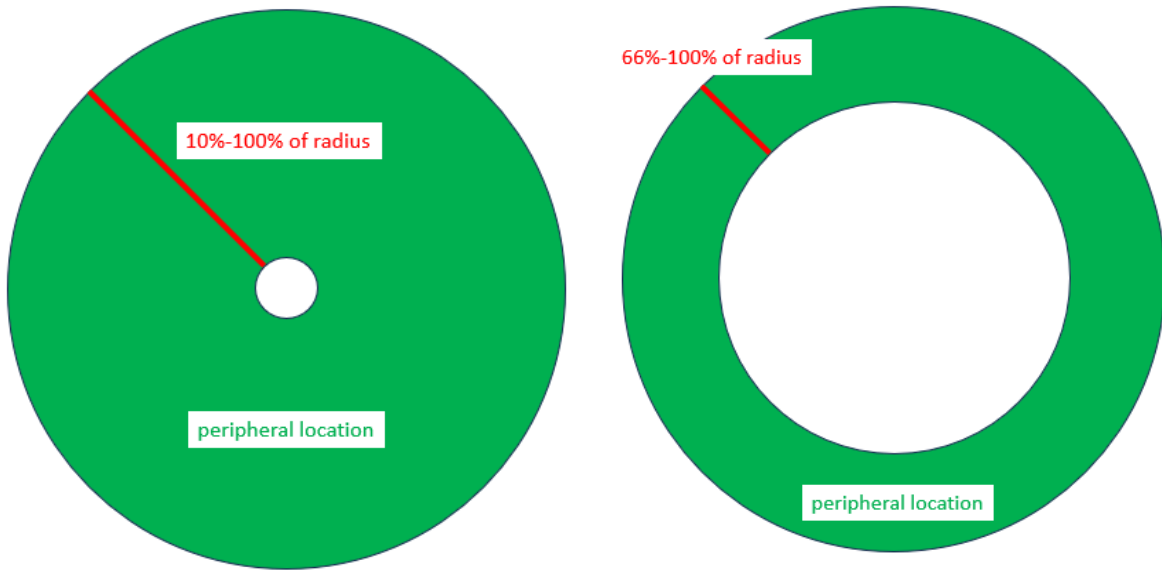
characteristic, property, state, structure, item, or result.” Moreover, the term “peripheral location” refers to “any particle of a dresser that is located in an area that originates at the leading edge or outer rim of a dresser and extends inwardly towards the center for up to about 90% of the radius of the dresser.” EX1001, 4:30-39. In other words, the ’862 Patent refers to the peripheral location that extends outwardly from about 10% to 100% of the radius. EX1002, ¶¶122-123.



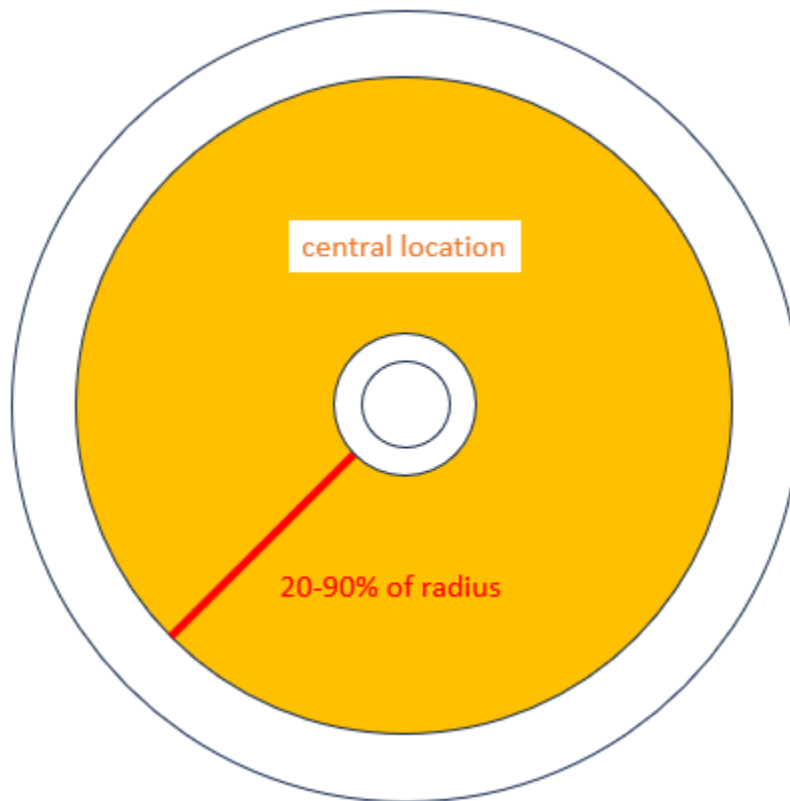
Even assuming these are lexicographic definitions that must be applied, Sung’026 discloses the added limitation of [9], because it discloses an embodiment

where the superabrasive particles are only in the area that extends outwardly from about 20% to 100% of the radius, which encompasses the claimed 10% to 100% of the radius of a [peripheral location](#). EX1002, ¶124.

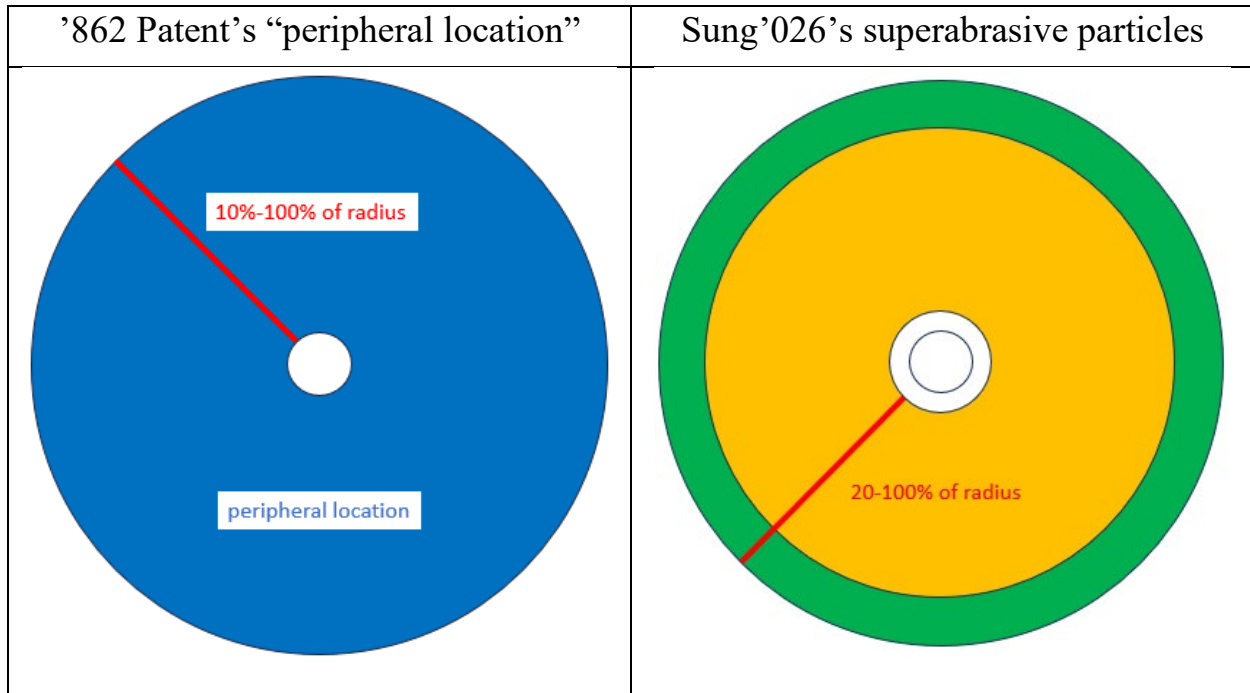
Sung’026 discloses various embodiments of an abrading tool with different configurations of superabrasive particles in “[central](#)” vs. “[peripheral](#)” locations. *See, e.g.*, EX1004, [0012], (“In one aspect, superabrasive particles in a central location of the abrading tool may be larger in size than superabrasive particles in a peripheral location on the abrading tool.”), [0014] (“In a further aspect, superabrasive particles in a central location on the abrading tool may be spaced farther apart than superabrasive particles in a peripheral location on the abrading tool.”), [0054], [0057-58], [0060]. Sung’026 further provides a nearly identical description for particles in a “[peripheral location](#)” as the ’862 Patent’s “[peripheral location](#).” Sung’026 specifies that a “[peripherally located](#)” particle is “in an area that originates at the leading edge or outer rim of a tool and extends inwardly towards the center for *up to about* 90% of the radius of the tool”—in other words, the area that extends outwardly from about 10% to 100% of the radius. *See* EX1004, [0037]. In another example, Sung’026 provides an example of “[peripherally located](#)” as an “area [that] may extend in to about 33% of the radius of a dresser (i.e., 66% away from the center).” EX1004, [0037].



Moreover, Sung’026 provides an example of a “**central location**,” which encompasses an “area [that] may extend outwardly from about 20% to about 90% of the radius.” EX1004, [0036]. In other words, the region from the center of the disk to about 20% of the radius is devoid of superabrasive particles in this particular example.



In other words, because the ordinary meaning of the term “peripheral” is an area that is outside of a “central” location, Sung’026 discloses an embodiment where the superabrasive particles are located in the area that extends outwardly from 20% (inner boundary of the “central location”) to 100% (outer boundary of the “peripheral location”) of the radius. This is encompassed by the claimed “peripheral location” limitation that extends outwardly from about 10% to 100% of the radius.



EX1002, ¶¶125-128.

Thus, Sung'026 teaches the added limitation of [9]. EX1002, ¶129.

4. Dependent Claim 5

- i. [5] The method of claim 1, wherein substantially all of the asperities are cut in the CMP pad by superabrasive particles located at a peripheral location of the dresser.

As explained above in Section X.A.3 [Ground I, 9], Sung'026 teaches “wherein substantially all of the superabrasive particles are located at a peripheral location of the dresser.” And because Sung'026 discloses an embodiment where *all* of the superabrasive particles are located at a peripheral location of the dresser, “substantially all of the asperities” are necessarily “cut in the CMP pad” by those superabrasive particles located at a peripheral location of the dresser. Indeed,

Sung’026 explains that the “protruding superabrasive particles 12 can cut into the CMP pad” EX1004, [0076]. EX1002, ¶¶130-131.

5. Dependent Claim 6

- i. [6] The method of claim 5, wherein the peripheral location extends from an outer edge of the dresser inwardly toward a center point of the dresser for up to about 90% of the dresser radius.**

As explained in Sections X.A.3 and X.A.4 [Ground I, 9 and 5], Sung’026 teaches superabrasive particles that are within “the peripheral location [that] extends from an outer edge of the dresser inwardly toward a center point of the dresser for up to about 90% of the dresser radius” (*i.e.*, within an area extending outwardly from about 10% to 100% of the radius of the dresser). Thus, Sung’026 teaches the added limitation of [6]. EX1002, ¶132.

6. Dependent Claim 10

- i. [10] The method of claim 1, wherein substantially all of the superabrasive particles are arranged in uniform predetermined pattern at a peripheral location of the dresser.**

Sung’026 anticipates the added limitation of [10]. As explained above in Section X.A.3 [9], Sung’026 teaches superabrasive particles that are arranged within a peripheral location of the dresser. Sung’026 further teaches that the superabrasive particles are arranged to “form a grid pattern with an inter-diamond pitch of about 500 microns.” EX1004, [0094]; *see also id.*, [0040] (“As used herein, ‘grid’ means

a pattern of lines forming multiple squares.”), claim 25 (“wherein the plurality of superabrasive particles are evenly spaced at a distance of from about 3 times to about 5 times the average size of the superabrasive particles.”). Hence, Sung’026 teaches the added limitation of [10]. EX1002, ¶¶133-135.

7. Dependent Claim 11

**[11A] The method of claim 1, further comprising:
rotating the CMP pad;**

Sung’026 discloses the added limitation of [11A]. Sung’026 discloses that the CMP pad rotates during the CMP process. EX1004, [0002] (“Such polishing processes generally entail applying the wafer against a *rotating pad* made from a durable organic substance such as polyurethane. A chemical slurry is ... continually added to the *rotating CMP pad*, and the dual chemical and mechanical forces exerted on the wafer cause it to be polished in a desired manner.”). EX1002, ¶¶136-137.

**i. [11B] applying a slurry to a polishing surface of the
rotating CMP pad;**

Sung’026 discloses limitation [11B]. Sung’026 discloses that a “slurry is continually added to the rotating CMP pad.” EX1004, [0002]. Sung’026 further teaches that the “*chemical slurry* is utilized that contains a chemical capable of breaking down the wafer substance and an amount of abrasive particles which *act to physically erode the wafer surface.*” *Id.* In other words, because the slurry is applied to a polishing surface of the rotating CMP pad, “the dual chemical and

mechanical forces exerted on the wafer cause it to be polished in a desired manner.”

Id.; *see also id.*, [0004]-[0005], [0081], [0098]. EX1002, ¶¶138-140.

ii. [11C] applying a workpiece to the polishing surface such that the workpiece is polished by the asperities in combination with the slurry.

Sung’026 discloses limitation [11C]. *First*, Sung’026 discloses applying a workpiece, such as a wafer, to the polishing surface of the CMP pad dresser. *See* EX1004, [0002] (“Many industries utilize a chemical mechanical polishing (CMP) process for polishing certain *work pieces*... Such polishing processes generally entail applying the wafer against a rotating pad made from a durable organic substance such as polyurethane.”) (emphasis added). Indeed, Sung’026 explains the necessity of maintaining uniform asperity depth for effective polishing, further confirming the fact that the workpiece is polished by the asperities. EX1004, [0005] (“Furthermore, pad dressers that cut asperities in the pad and... that do not overdress the pad must be used.”), [0004] (explaining the need to “revive the pad surface by ... ‘cutting’ it” because the asperities become “clogged,” “depressed and matted.”); *see also* EX1005, 1:2-4 (confirming that “[t]he polishing rate of a wafer is dependent on the amplitude (height) of pad asperities. The polishing uniformity is controlled by the frequency (density) of such asperities.”). EX1002, ¶¶141-142.

Second, Sung’026 discloses that the wafer is polished by the asperities in the CMP pad in combination with the slurry. For example, Sung’026 discloses that a

“chemical slurry ... is continually added to the rotating CMP pad, and the dual chemical and mechanical forces exerted on the wafer cause it to be polished in a desired manner.” EX1004, [0002]. EX1002, ¶¶143-144.

8. Dependent Claim 12

i. [12] The method of claim 11, wherein the workpiece is a semiconductor device.

Sung’026 discloses the added limitation of [12]. Specifically, Sung’026 discloses that the CMP pad dresser is used to condition a CMP pad that is used to polish a semiconductor device, such as a semiconductor chip. EX1004, [0005] (“Ultra-large-scale integration (ULSI) is a technology that places at least 1 million circuit elements on *a single semiconductor chip*... Therefore, the CMP industry has been required to respond by providing polishing materials and techniques that accommodate these advances.”), [0008] (“As a result, a CMP pad dresser that is suitable for dressing a CMP pad that meet[s] the demands placed upon the CMP industry by the continual reductions in *semiconductor* size is still being sought.”), [0002] (“Many industries utilize a chemical mechanical polishing (CMP) process for polishing certain *work pieces*. Particularly, the *computer* manufacturing industry relies heavily on CMP processes for *polishing wafers of* ceramics, *silicon*, glass, quartz, and metals. Such polishing processes generally entail applying the wafer against a rotating pad made from a durable organic substance such as

polyurethane.”). EX1002, ¶¶145-146.

9. Dependent Claim 20

- i. [20] The method of claim 11, wherein the CMP pad is polyurethane.**

Sung’026 discloses the added limitation of [20]. Sung’026 discloses that the CMP pad is polyurethane. EX1004, [0002] (“Such polishing processes generally entail applying the wafer against a rotating pad made from a durable organic substance such as *polyurethane*.”). EX1002, ¶147.

B. Ground II: Sung’026 With SungICPT Renders Obvious Claims 5-10

1. Dependent Claim 9

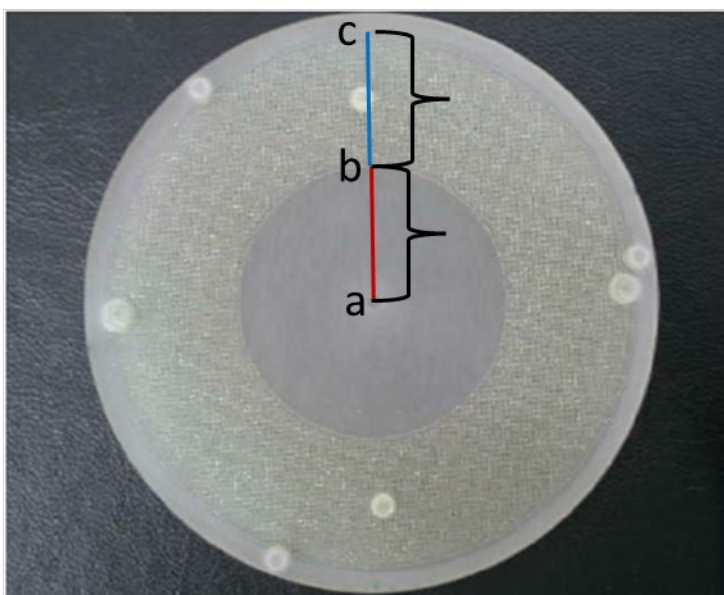
- i. [9] The method of claim 1, wherein substantially all of the superabrasive particles are located at a peripheral location of the dresser.**

As explained in Section X.A.3 [Ground I, 9], Sung’026 teaches the added limitation of [9]. EX1002, ¶148.

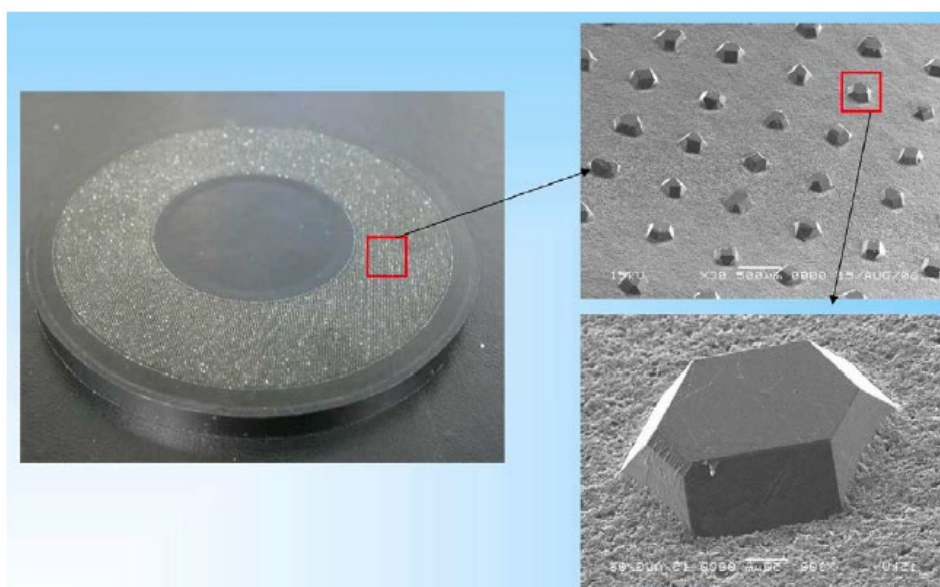
Alternatively, Sung’026 in combination with SungICPT renders the claimed limitation obvious. In addition to the teachings of Sung’026, SungICPT shows multiple images of such a CMP pad dresser having all of the superabrasive particles located at a peripheral location. *See* EX1005, Figs. 1-3. For example, as shown below in Figure 1, substantially all of the superabrasive particles are located in an

area that originates at the leading edge or outer rim of a tool and extends inwardly towards the center for about 50% of the radius of the dresser.

distance from a to b $\approx$ distance from b to c



EX1005, Fig. 1 (annotated).



EX1005, Fig. 3. Hence, SungICPT also discloses an example where *all* of the superabrasive particles are located at a peripheral location of the dresser. EX1002, ¶¶149-153.

2. Dependent Claim 5

- i. **[5] The method of claim 1, wherein substantially all of the asperities are cut in the CMP pad by superabrasive particles located at a peripheral location of the dresser.**

As explained in Section X.A.4 [Ground I, 5], Sung’026 teaches the added limitation of [5]. EX1002, ¶154.

Alternatively, as explained above in Section X.B.1 [Ground II, 9], Sung’026 in combination with SungICPT renders obvious “wherein substantially all of the superabrasive particles are located at a peripheral location of the dresser,” because SungICPT discloses an example where *all* of the superabrasive particles are located at a peripheral location of the dresser. Such example from SungICPT also teaches the added limitation of [5], because when *all* of the superabrasive particles are located at a peripheral location of the dresser, “substantially all of the asperities” are necessarily “cut in the CMP pad” by those superabrasive particles located at a peripheral location of the dresser. *See* Section X.A.4 [Ground I, 5]. Indeed, both Sung’026 and SungICPT confirm that the superabrasive particles cut the CMP to form asperities. For example, Sung’026 explains that the “protruding superabrasive particles 12 can cut into the CMP pad to a depth that is essentially the distance of

the protrusion.” EX1004, [0076]. Furthermore, SungICPT explains that “all diamond grits [located in the peripheral location of the dresser] are sharing the dressing work. ... Moreover, because no diamond will cut pad unnecessarily, the pad life is greatly lengthened. Furthermore, due to the uniform distribution of pad asperities, the slurry will be held efficiently so the run off is avoided.” And what results is a much more uniform asperities that can polish wafers fast with high uniformity. See EX1005, 1:12-16; 5:4-5 (“[T]he asperities of the pad dressed by ODD are much more uniform.”), 6:21-22 (“ODD can create densely populated pad asperities that can polish wafers fast but with high uniformity.”). EX1002, ¶¶155-157.

3. Dependent Claims 6-7

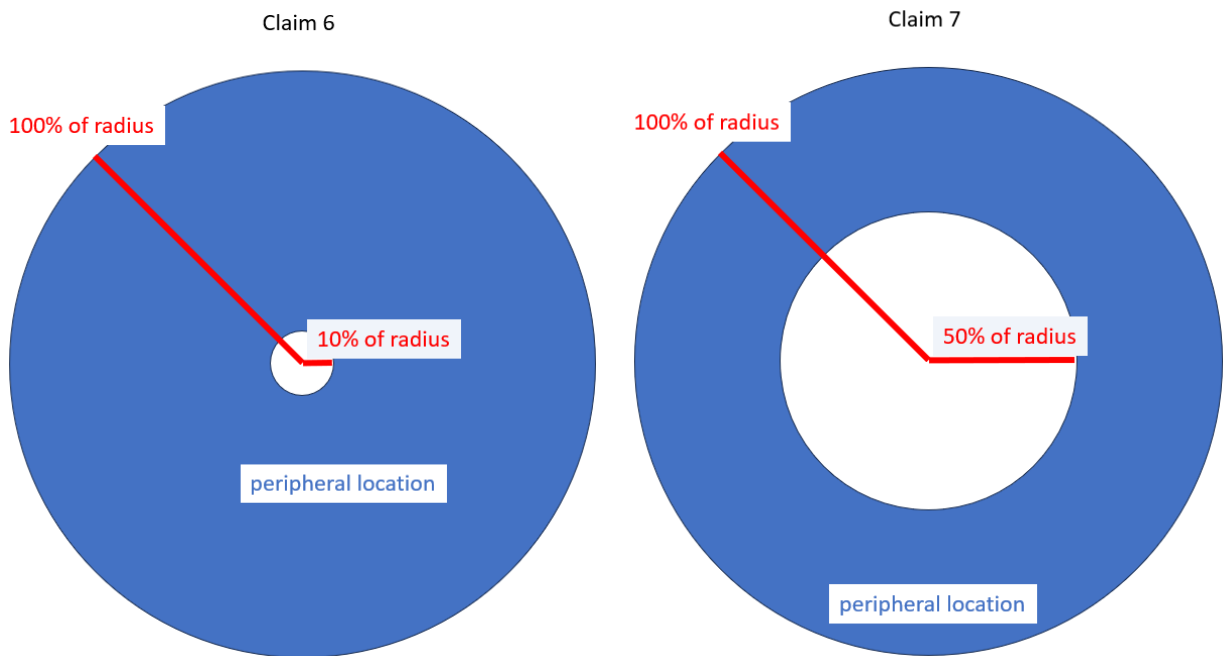
- i. **[6] The method of claim 5, wherein the peripheral location extends from an outer edge of the dresser inwardly toward a center point of the dresser for up to about 90% of the dresser radius.**

[7] The method of claim 5, wherein the peripheral location extends from an outer edge of the dresser inwardly toward a center point of the dresser for up to about 50% of the dresser radius.

As explained in Section X.A.5 [Ground I, 6], Sung’026 discloses the added limitation of [6]. EX1002, ¶158.

To be clear, claim 6 is merely a restatement of the term “peripheral location” refers to “any particle of a dresser that is located in an area that originates at the

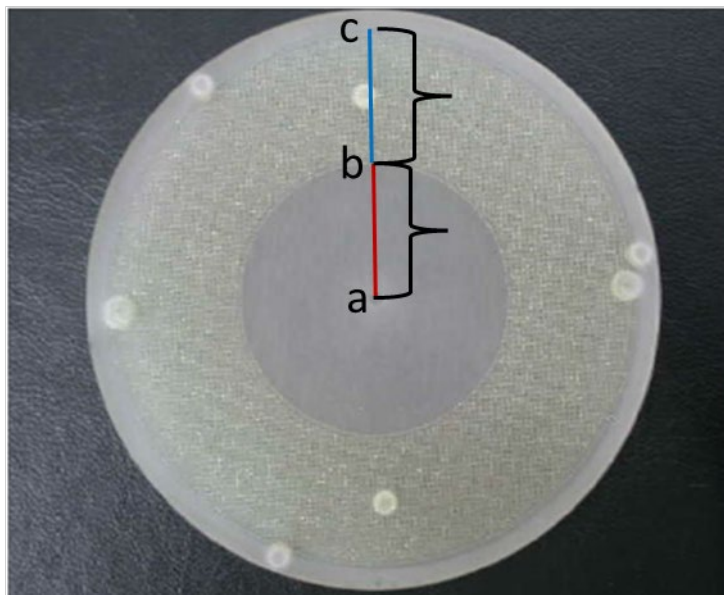
leading edge or outer rim of a dresser and extends inwardly towards the center for up to about 90% of the radius of the dresser.” EX1001, 4:30-39. Claim 7, on the other hand, arguably redefines the boundary of the peripheral location to extend inwardly towards the center for up to about 50% of the radius of the dresser. These upper limits are graphically illustrated below. Hence, embodiments where the superabrasive particles residing only within the blue colored regions teach the additional limitations of [6] and [7]. EX1002, ¶¶159-160.



Sung’026 in combination with SungICPT renders both claims 6 and 7 obvious, because SungICPT provides a specific example of a CMP pad dresser having the superabrasive particles located peripherally beginning from about 50% of the radius and extending outward, thereby reading on [6] and [7]. Specifically, as

shown in the annotated Figure 1 below, the distance from the center to superabrasive particles is about $\frac{1}{2}$ (or 50%) of the radius and the superabrasive particles extend outwardly from there towards the outer edge of the dresser up to the position marked by “c.”

distance from a to b $\approx$ distance from b to c



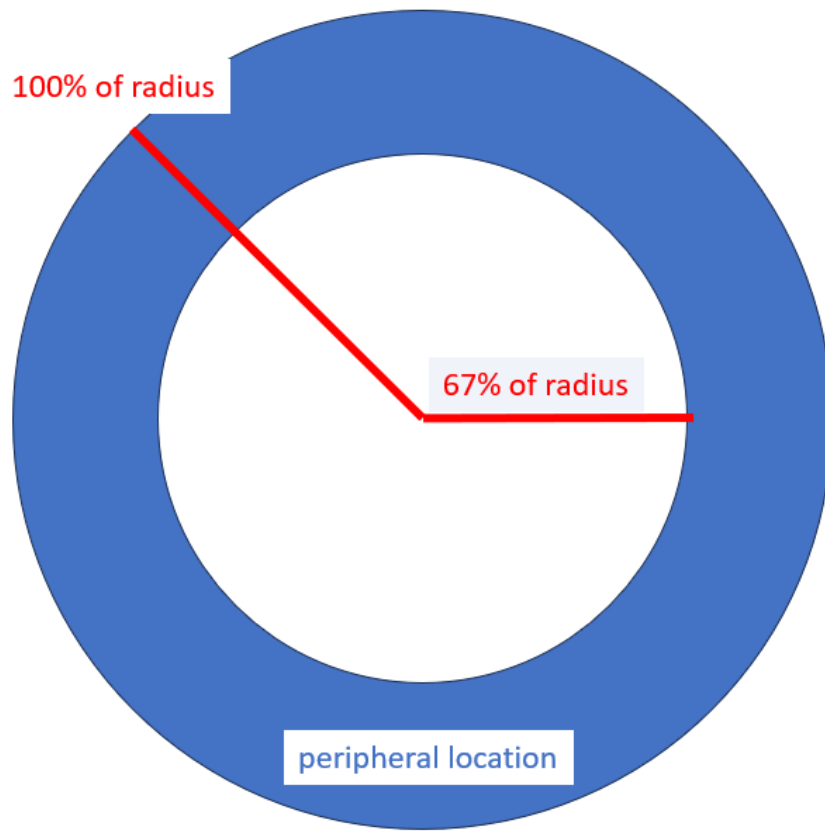
EX1005, Fig. 1 (annotated). EX1002, ¶161.

4. Dependent Claim 8

- i. [8] The method of claim 5, wherein the peripheral location extends from an outer edge of the dresser inwardly toward a center point of the dresser for up to about 33% of the dresser radius.

To be clear, claim 8 arguably redefines the boundary of the peripheral location to extend inwardly towards the center for up to 33% of the radius. This upper limit is graphically illustrated below. EX1002, ¶¶162-163.

Claim 8



Sung'026 with SungICPT renders obvious the added limitation of [8]. As explained in Section X.B.3 [Ground II, 6 and 7], SungICPT provides one example of a CMP pad dresser having superabrasive particles located peripherally for about 50% of the radius. *See* EX1005, Fig. 1. While SungICPT's exemplary CMP pad dresser does not have a peripheral location that extends from an outer edge of the dresser inwardly toward a center point of the dresser for up to about 33% of the dresser radius (*i.e.*, from 67% of the radius extending to 100% of the radius), there is nothing inventive about the exact location of where the diamond particles should

be placed on the CMP pad dresser, and making a CMP pad dresser within the ranged claimed in [8] would have been obvious. EX1002, ¶164.

For example, Sung’026 discloses that a “peripherally located” particle is “in an area that originates at the leading edge or outer rim of a tool and extends inwardly towards the center for up to about 90% of the radius of the tool,” providing additional examples of “about 50% of the radius” and “about 33% of the radius of a dresser.” See EX1004, [0037]. EX1002, ¶164.

Sung’026 further explains that “superabrasive particles located near the periphery will most likely experience greater frictional force than particles located more centrally due to the greater rotational velocity at the periphery.” EX1004, [0057]. And to account for such differences, Sung’026 contemplates different techniques for arranging the superabrasive particles differently across the central and peripheral locations. See EX1004, [0057], [0060], [0076]. As such, a POSITA would have found it obvious to try to place “substantially all of the superabrasive particles are located at a peripheral location of the dresser” to account for the fact that the particles located near the periphery will most likely experience greater frictional forces and to even out the frictional force experienced by the CMP pad. EX1002, ¶164.

The exact boundary, such as “about 33% of the radius of a dresser” would have been a routine and trivial modification. Making a CMP pad dresser having a

peripheral location that extends either 50% or 33% would have been a trivial modification among a finite number of options provided in the prior art, such as Sung'026. EX1002, ¶165.

At a minimum, it would have been obvious to try different amounts of diamond particles to arrive at the claimed configuration of about 33% of the radius of a dresser, which is one of the boundaries suggested by Sung'026. *See* EX1004, [0037]. EX1002, ¶165.

And because Sung'026 discloses that “peripherally located” can equally be “in an area that originates at the leading edge or outer rim of a tool and extends inwardly towards the center for up to ... about 50% of the radius” and “about 33% of the radius of a dresser,” a POSITA would have found it obvious to modify the CMP pad dresser of SungICPT to only have the superabrasive particles cover the area from the outer rim to about 33% of the radius of a dresser with a reasonable expectation of success. EX1002, ¶165.

5. Dependent Claim 10

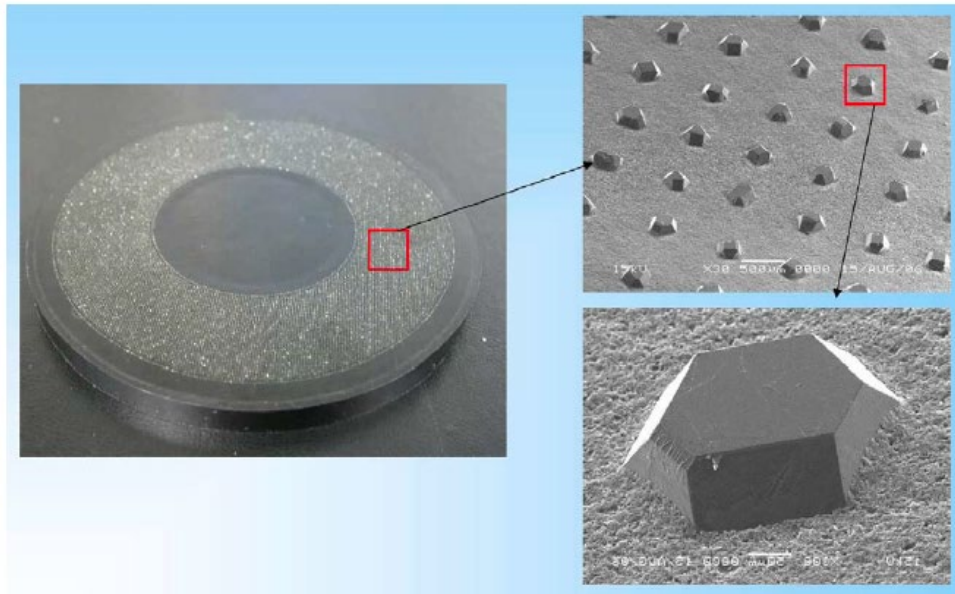
- i. [10] The method of claim 1, wherein substantially all of the superabrasive particles are arranged in uniform predetermined pattern at a peripheral location of the dresser.**

As discussed in Section X.A.6 [Ground I, 10], Sung'026 anticipates the added limitation of [10]. Alternatively, Sung'026 and SungICPT render obvious the added

limitation of [10]. **First**, as already discussed in Section X.B.1 [Ground II, 9], Sung’026 and SungICPT render obvious a CMP pad dresser where “substantially all of the superabrasive particles are ... at a peripheral location of the dresser.” EX1002, ¶¶166-168.

Second, both Sung’026 and SungICPT disclose the added limitation that the superabrasive particles are “arranged in uniform predetermined pattern.” Sung’026 discloses that the superabrasive particles can be arranged as a grid with even or uniform spacing. EX1004, [0060] (“the plurality of superabrasive particles may be arranged as a grid. Though the even or uniform spacing of the superabrasive particle can exhibit wide variation across abrading tools, in one specific aspect *the plurality of superabrasive particles may be evenly spaced* at a distance of from about 2 times to about 4 times the average size of the superabrasive particles.”). EX1002, ¶¶169-170.

Similarly, SungICPT discloses that the diamond grits in the ODD dresser have uniform spacing. EX1005, 1:11-12 (“Due to the uniform spacing of diamond grits and their controlled tip heights, none of the diamond grits will be overly stressed.”). This is also illustrated in Figure 3 of SungICPT (reproduced below), which shows a diamond disk having only peripherally located uniformly spaced particles in a grid pattern.



EX1005, Fig. 3. Accordingly, Sung’026 and SungICPT render obvious the added limitation of [10]. EX1002, ¶¶171-172.

6. Reasons To Combine Sung’026 with SungICPT

A POSITA would have had numerous reasons to combine Sung’026 with SungICPT. **First**, Sung’026 and SungICPT are analogous art as the claimed CMP pad dressers. EX1004, [0009] (“Accordingly, the present invention provides superabrasive tools and methods that are, without limitation, suitable to groom the CMP pads used for the delicate polishing applications.”); EX1005, Title (“The Organic Diamond Disk (ODD) for Dressing Polishing Pads of Chemical Mechanical Planarization.”); EX1001, claim 1 (“A method of conditioning a CMP pad”). EX1002, ¶174.

Second, Sung’026 and SungICPT are directed to the same type of CMP pad

conditioners with an organic matrix, and both are made by “reverse casting.” EX1004, [0083] (“Various *reverse casting* methods may be utilized to manufacture the CMP pad dresser of the present invention.”); [0075] (“Referring to FIG. 1, the CMP pad dresser **20** may include an organic material layer **14** and superabrasive particles **12** held in the organic material layer **14** in an arrangement according to the various methods presented herein.”); EX1005, 1:9-11 (“New designs of diamond pad conditioners have markedly improved the leveling of diamond tips. Organic diamond disks (ODD) are manufactured by *reverse casting* of polymers.”); 1:30-2:3 (“A new design by reversing the diamond attaching process is made with an organic matrix (e.g. epoxy). The diamond grits⁹ are first leveled to a mold surface. Subsequently, they are cast by covering with a polymer.”). As the methods of making the CMP pad dressers are the same, a POSITA would have found it obvious to try to combine the disclosures with a reasonable expectation of success. In fact, given the similarity of the methods, such a modification would have been trivial. EX1002, ¶176.

⁹ “Grit” is often used interchangeably with “particle”. For example, as Sung’026 explains, “‘particle’ and ‘grit’ may be used interchangeably, and when used in connection with a superabrasive material, refer to a particulate form of such material.” EX1004, [0033]. EX1002, ¶¶43, 64, .

Third, both Sung'026 and SungICPT disclose that the abrasive tools perform better if the superabrasive particles are leveled. EX1004, [0056] (“In yet another aspect, the plurality of superabrasive particles are arranged such that their tips vary from the designated profile by less than about 1 microns.”), [0073] (“By minimizing the variance in the protrusion of the plurality of superabrasive particles above the solidified organic material layer, mechanical forces impinging on individual superabrasive particles can be minimized. ... In another aspect the variation from the predetermined height may be from about 1 micron to about 20 microns.”); EX1005, 2:2-4 (“Due to the pre-leveling of the diamond tips, their height variation is within 20 microns. This organic diamond disk (ODD) will dress pad uniformly without excessive cutting.”). A POSITA would have been motivated to combine references that both recognize benefits of having leveled height of superabrasive particles. And a POSITA would have considered leveling the height of the superabrasive particles to the level taught by the prior art references, such as a tip-to-tip variation that is less than about 2 microns. EX1002, ¶175.

Finally, a POSITA would have been able to make such CMP pad dressers having a tip variation that is less than about 2 microns with a reasonable expectation of success because they both utilize the same “reverse casting” process to make the CMP pad dressers, as described above. In fact, given the similarity of the methods, such a modification would have been trivial. At a minimum, a POSITA would have

found it obvious to try to combine the disclosures of Sung'026 with SungICPT to achieve as uniform tip variation as possible with a reasonable expectation of success.

EX1002, ¶177.

C. Ground III: Sung'026 And Nishioka Renders Obvious Claims 13 And 17-19

1. Dependent Claim 13

- i. [13] The method of claim 12, wherein the semiconductor device includes one or more layers of Cu, W, an oxide layer, or a combination thereof.**

Sung'026 in combination with Nishioka renders obvious the added limitation of [13]. Sung'026 states that “[u]ltra-large-scale integration (ULSI) is a technology that places at least 1 million circuit elements on a single semiconductor chip.” EX1004, [0005]. And as already discussed in Section X.A.8 [12], Sung'026 discloses that the CMP pad dresser is used to condition a CMP pad, which in turn is used to polish a semiconductor. See EX1004, [0005], [0008]. However, Sung'026 does not provide additional details about what layers are included in the semiconductor device. EX1002, ¶¶178-179.

But semiconductor devices that include one or more layers of copper and oxides were well-known in the art. For example, Nishioka discloses that *copper* or a copper alloy has been used as wiring metal in a semiconductor device to “prevent a problem of wiring delay.” EX1006, [0003], [0040]. Additionally, Nishioka lists silicon *oxide* (SiO₂) as an example of inter-layer dielectric film in a semiconductor

device. *Id.*, [0085] (“The insulating film includes one generally used as an inter-layer dielectric film or a cap layer. A compound forming an insulating film includes an inorganic silicon compound containing a large amount of silicon (e.g. ***silicon oxide (SiO₂)***.”). Indeed, CMP (and therefore CMP pad dressers) are routinely utilized to planarize these types of materials. *See* EX1006, [0002] (“[C]hemical mechanical polishing process is employed in planarization of an inter-layer dielectric film, a metal plug, a metal wiring, etc., during multi-layer wiring steps.”). EX1002, ¶¶180-182.

2. Dependent Claims 17-19

- i. [17] **The method of claim 11, wherein the slurry includes an abrasive selected from the group consisting of silica, alumina, ceria, and combinations thereof.**

[18] **The method of claim 11, wherein the slurry includes an oxidative compound.**

[19] **The method of claim 17, wherein the oxidative compound is hydrogen peroxide.**

Sung’026 in combination with Nishioka renders obvious the added limitations of [17]-[19]. Sung’026 discloses that the CMP process includes using a chemical slurry that contains (1) “a chemical capable of breaking down the wafer substance” and (2) “abrasive particles which act to physically erode the wafer surface.” EX1004, [0002]. However, Sung’026 does not provide specific examples of either the “chemical” or the “abrasive” used in the slurry. EX1002, ¶¶183-184.

Nevertheless, the fact that a slurry includes an abrasive and an oxidative compound such as hydrogen peroxide were well-known in the art. *See* EX1006, [0055] (“The chemical-mechanical polishing composition of the present invention comprises a dicarboxylic acid, ***an oxidizing agent, an abrasive***, and water.”). For instance, Nishioka lists several suitable slurry abrasives, including silica, alumina, and ceria. EX1006, [0066] (“The abrasive used for the polishing composition of the present invention includes ***silica, cerium oxide, aluminum oxide***¹⁰.”). Similarly, Nishioka teaches an oxidizing agent (*i.e.*, an oxidative compound) such as hydrogen peroxide. EX1006, [0063] (“Examples of the aforementioned ***oxidizing agent*** include oxygen, ozone, ***hydrogen peroxide*** ... Among these oxidizing agents, ***hydrogen peroxide***, persulfate salts and hypochlorites, which can be simply handled, are preferred. In particular, ***hydrogen peroxide*** is preferred.”). EX1002, ¶¶185-187.

3. Reasons To Combine Sung’026 And Nishioka

It would have been obvious to combine the teachings of Sung’026 with Nishioka. Nishioka, like Sung’026, discloses the use of CMP in the production of semiconductors. EX1006, [0002] (“large scale integration circuits ... have provided improvements in operating speeds and degrees of integration ... by virtue of

¹⁰ “Ceria” is synonymous with “cerium oxide,” and “alumina” is synonymous with “aluminum oxide.” EX1002, ¶186.

developments in micro-processing techniques ... [such as] chemical-mechanical polishing process [which] is employed in planarization of an inter-layer dielectric film, a metal plug, metal wiring, etc. during multi-layer wiring steps.”); EX1004, [0005] (“In addition to the tremendous density issues that already exist, with the current movement toward size reduction, ULSI has become even more delicate, both in size and materials than ever before. Therefore, the CMP industry has been required to respond by providing polishing materials and techniques that accommodate these advances.”). Using Sung’026’s CMP process when making Nishioka’s semiconductor that includes copper and/or silicon oxide layers would have amounted to nothing more than combining known prior art elements according to known methods to yield predictable results. EX1002, ¶188.

Similarly, a POSITA would have been motivated, with a reasonable expectation of success, to look at Nishioka for guidance on the specific components of the CMP slurry, *i.e.*, (1) “chemical capable of breaking down the wafer substance” and (2) “abrasive particles which act to physically erode the wafer surface.” EX1004, [0002]. Nishioka simply provides specific examples of these well-known slurry components, and a POSITA would have readily known that they can be used in Sung’026’s slurry with no change in its function. In fact, given that Sung’026 discloses the type of agents needed in the slurry, such a combination to select the specific abrasive and oxidative compound would have been trivial, and a POSITA

would have been able to combine the teachings of Sung'026 and Nishioka with a reasonable expectation of success. EX1002, ¶189.

D. Ground IV: Sung'026 And Lin Renders Obvious Claim 14

1. Dependent Claim 14

- i. [14] The method of claim 12, wherein the semiconductor device has a node size of less than or equal to 28 nm.**

Sung'026 in combination with Lin renders obvious the added limitation of [14]. As discussed in Section X.A.8 [12], Sung'026 discloses that the CMP pad dresser is used to condition a CMP pad that in turn is used to polish a semiconductor. EX1002, ¶¶190-191.

Sung'026 does not provide additional details about the semiconductor device, such as the node size, which represents size of the features in the semiconductor device. *See* EX1007, [0028] (“The interconnect feature is a trench or via located in a semiconductor substrate and has a bottom, a sidewall, and an opening. Typical dimensions of the opening, i.e., diameter of a via opening (commonly referred to as a node) or width of a trench, are typically less than about 500 nm”). Nevertheless, a POSITA would have found it obvious that CMP is often used in making semiconductor devices of various node sizes, including node size of less than or equal to 28 nm. For example, Lin describes using CMP in semiconductor devices, having node sizes that are 22nm and 15nm. *See* EX1007, [0035] (“Then the

workpiece is subjected to conventional finishing operations of annealing and ***chemical-mechanical polishing (CMP)*** to yield a metallized ***interconnect feature*** in which the copper metallization is planar with the field of the dielectric, as shown in FIG. 1E.”), [0028] (“The ***interconnect feature*** ... has ... an opening. Typical dimensions of the opening, i.e., diameter of via opening (commonly referred to as a ***node***) ... may be as little as about 10 nm... ***Common nodes include*** 130 nm, 90 nm, 65 nm, 45 nm, 32 nm, ***22 nm, and 15 nm.***”), [0055]-[0057], [0059]. EX1002, ¶192.

2. Reasons To Combine Sung’026 And Lin

A POSITA would have had numerous reasons to combine Sung’026 with Lin. Sung’026 discloses a CMP process for polishing ULSI devices that include at least 1 million circuit elements on a single semiconductor chip, and Lin discloses a method of preparing such a ULSI device by a method that includes CMP. EX1004, [0005], EX1007, [0004], [0035], [0055]-[0057], [0059]. A POSITA would have been able to use Sung’026’s CMP process on Lin’s device because Sung’026 teaches a CMP pad dresser and polishing process made for such devices. In fact, given the similarity of the methods, such a combination would have been trivial. At a minimum, a POSITA would have found it obvious to try to combine the disclosures of Sung’026 and Lin to use Sung’026’s CMP process on Lin’s semiconductor device having a node size of less than or equal to 28 nm with a reasonable expectation of success. EX1002, ¶193.

E. Ground V: Sung'026 And Kim Renders Obvious Claim 15

1. Dependent Claim 15

- i. [15] The method of claim 12, wherein the semiconductor device has a line width of less than or equal to about 30 nm.**

Sung'026 in combination with Kim renders obvious the added limitation of [15]. As discussed in Section X.A.8.i [12], Sung'026 discloses that the CMP pad dresser is used to condition a CMP pad that in turn is used to polish a semiconductor. EX1002, ¶¶194-195.

Sung'026 does not provide additional details about the semiconductor device, such as the line width, which represents the width of a metal line to which the gates of the transistors are connected to. *See* EX1008, [0002]-[0003]. Nevertheless, a POSITA would have found it obvious that CMP is often used in making semiconductor devices of various line widths, including line widths of less than or equal to about 30 nm. *See* EX1008, [0043]-[0045]. For example, Kim describes that before the earliest claimed priority date of the '862 Patent the width of the metal line had decreased to approximately 30 nm as the level of integration of semiconductor devices had increased. EX1008, [0022] ("In recent years, however, as the level of integration of semiconductor devices has increased, the width of the metal line has decreased (approximately 60 nm to **30 nm**) and the resistivity of the metal line has increased," [0024] ("From the graph of FIG. 1, it can be seen that

aluminum (Al) and copper (Cu) have a lower resistivity than tungsten (W) at a narrow line width of 60 nm to 30 nm,” EX1002, ¶196.

2. Reasons To Combine Sung’026 And Kim

A POSITA would have had numerous reasons to combine Sung’026 with Kim. Sung’026 discloses a CMP process for polishing ULSI devices that include at least 1 million circuit elements on a single semiconductor chip, and Kim similarly discloses semiconductor devices with increased level of integration. *See* EX1004, [0005]; EX1008, [0003]. A POSITA would have been able to use Sung’026’s CMP process on Kim’s semiconductor device because Sung’026 teaches a CMP pad dresser and polishing process made for such devices. In fact, given the similarity of the methods, such a combination would have been trivial. At a minimum, a POSITA would have found it obvious to try to combine the disclosures of Sung’026 and Kim to apply Sung’026’s process designed for Ultra-large-scale integration (ULSI) devices to Kim’s devices having a line width of 30 nm with a reasonable expectation of success. EX1002, ¶197.

F. Ground VI: Sung’026 And Koyama Renders Obvious Claim 16

1. Dependent Claim 16

- i. [16] The method of claim 12, wherein the semiconductor device is a wafer having a size greater than 400 mm.**

As already discussed in Section X.A.8 [12], Sung’026 discloses that the CMP

pad dresser is used to condition a CMP pad that in turn is used to polish a semiconductor wafer. EX1002, ¶199.

Sung’026 does not provide additional details about the semiconductor device, such as the size of the wafer. Nevertheless, a POSITA would have found it obvious that CMP is often carried out on semiconductor wafers, including wafers that have a size greater than 400 mm. For instance, Koyama describes semiconductor substrate wafers of various sizes, including an 18-inch wafer (about 450 mm), that were available long before the ’862 patent and on which CMP can be carried out. EX1009, [0062] (“As for a single crystal silicon substrate which is a typical example of the single crystal semiconductor substrate, circular wafers which are 5 inches in diameter (125 mm), 6 inches in diameter (150 mm), 8 inches in diameter (200 mm), and 12 inches in diameter (300 mm) are available. In addition, a *circular wafer which is 18 inches (450 mm) in diameter* is realized recently.”), [0135]-[0137] (“For the polishing treatment, a chemical mechanical polishing (CMP) method, a mechanical polishing method, a liquid jet polishing method, or the like can be used.”). EX1002, ¶200.

2. Reasons To Combine Sung’026 And Koyama

A POSITA would have had numerous reasons to combine Sung’026 with Koyama. A POSITA would have found that using a Koyama’s wafer having a size of 450 mm would be a simple substitution of one known element (Sung’026’s

“wafer”) for another (Koyama’s 450 mm wafer) to obtain predictable results. Indeed, using Sung’026’s method to polish a larger wafer would have been a trivial modification because Sung’026’s process is not size-restricted, and Koyama demonstrates the CMP’s applicability to 450 mm wafer sizes. EX1004, [0005]; EX1009, [0062]. EX1002, ¶201.

XI. Discretionary Factors Favor Institution

The discretionary factors the Board employs for its institution decisions favor institution.

A. *Advanced Bionics* Factors Favor Institution

The Board uses a two-prong test to determine whether it will deny institution under 35 U.S.C. § 325(d): (1) whether the same or substantially the same art or arguments were previously presented to the Office; and (2) if first part is satisfied, whether the Office erred in a manner material to the patentability of challenged claims. *See Advanced Bionics LLC v. MED-EL Elektromedizinische Geräte GmbH*, IPR2019-01469, Paper 6 (precedential).

At the outset, SungICPT, Nishioka, Lin, Kim, and Koyama were never considered during prosecution of the ’862 Patent and do not meet the first prong of *Advanced Bionics*.

Sung’026 is listed on the cover of the ’862 Patent. EX1001, Cover. But the second prong of *Advanced Bionics* favor institution.

Sung'026 was merely one out of about 510 documents submitted to the Examiner during examination, spanning 20 separate IDS submissions. EX1003, 58-65, 66-67, 134, 141, 855-858, 865-866, 873, 880, 881, 942, 944-945, 1158, 1167, 1174, 1181, 1237, and 1243. Sung'026 was never highlighted to the Office nor was there any substantive discussion of Sung'026 in the file history. And, Sung'026 was not relied upon in any substantive rejections by the Office during the original prosecution of the '862 Patent. Indeed, Grounds based on references cited in an IDS but not considered at any length should not serve as the basis for denying institution under 35 U.S.C. § 325(d). Indeed, the Board has repeatedly instituted IPRs where the relied-on references had been merely cited by the applicant among numerous references submitted in IDSs during prosecution of the original application, without forming a basis of any rejections by the examiner. *See Becton, Dickinson & Co. v. B. Braun Melsungen AG*, IPR2017-01586, Paper 8 at 17-18 (precedential); *see also Hum Industrial Technology, Inc. v. Amsted Rail Company, Inc.*, IPR2023-00539, Paper 10 at 51 (“We do not consider the Examiner’s initials on an IDS citing almost 100 references with the Examiner’s failure to use LeFebvre or Armitage to reject claims of the '673 patent application as indicating that the Examiner sufficiently evaluated or appreciated the relevance of either reference.”).

Accordingly, the Office erred by failing to apply Sung'026 under the second prong of *Advanced Bionics*.

1. Sung’026 Is Not The Same Art As Sung’869

To the extent Patent Owner argues that Sung’026 is substantially the same art to Sung’869 (which was applied by the Examiner in an Office Action as a secondary reference for one limitation—in combination with a primary reference Dinh-Ngoc (*see* EX1003, 892)), institution is again favored.

First, under the first part of *Advanced Bionics*, Sung’026 and Sung’869 are not substantially the same art. There is no claim of priority to each other to indicate any relationship between the two references. *See* EX1004, Cover; EX1012, Cover. Furthermore, the figures of Sung’026 and Sung’869 are different with respect to each other. EX1004, Figs. 1-8; EX1012, Figs. 1-5. Moreover, this Petition relies on Sung’026’s paragraph [0073] for limitations [1C] and [1D], which is not present in Sung’869. Accordingly, Sung’026 and Sung’869 cannot be considered to be the same art.

Second, to the extent the Patent Owner nevertheless argues that Sung’026 and Sung’869 are substantially the same art, institution is still favored under the second part of *Advanced Bionics* because the Examiner erred in accepting Applicant’s arguments as to Sung’869. As explained in Section VI.C [Prosecution History], the Examiner only cited to Sung’869’s teaching of superabrasive particles protruding to a predetermined height of less than about 20 microns as reading on the limitation “the difference in protrusion distance between the highest 10 protruding tips of the

monolayer of superabrasive particles are within about 20 microns or less; and rotating the dresser against the CMP pad ***such that asperities are cut into the CMP pad having a maximum cutting depth of about 60 microns.***” EX1003, 892 (emphasis added).

In response, Applicant overcame that rejection by arguing that the “Examiner ... infers that this recitation of cutting depth reads on the claim limitation that the highest 10 protruding tips are within about 20 microns or less. It is noted, however, that the depth to which a particle cuts into a deformable substance like a CMP pad is not necessarily a teaching of a protrusion distance of this particle.” EX1003, 1185. The Examiner accepted this argument without issuing another rejection based on Sung’869.

However, the Examiner erred because paragraph [0060] of Sung’869¹¹ teaches that “the plurality of superabrasive particles is arranged such that their tips vary from the designated profile by less than about 1 micron.” See EX1012, [0060]. As explained in greater detail in Sections X.A.1.iv and X.A.1.v [1C and 1D], the Examiner failed to appreciate this teaching of Sung’869, which discloses limitations [1C] and [1D].

¹¹ The Examiner only relied on paragraphs [0002], [0010], [0057]-[0059], [0061], and [0062] of Sung’869. See EX1003, 892-895.

As such, to the extent Patent Owner argues that Sung'026 and Sung'869 are substantially the same art because paragraph [0056] of Sung'026 contains the commensurate teaching as paragraph [0060] of Sung'869, the Examiner erred in not applying the most relevant teaching of Sung'869. Hence, institution is again favored under the second part of *Advanced Bionics*.

B. *Fintiv* Factors Favor Institution

The six *Fintiv* factors considered favor institution. *See Apple Inc. v. Fintiv, Inc.*, IPR2020-00019, Paper 11 (precedential).

1. No Evidence Regarding A Stay

No motion to stay has been filed, so this factor is neutral.

2. Parallel Proceeding Trial Date

The median time from filing to trial in the Eastern District of Texas is currently approximately 21 months, which means that trial is expected just shortly before or around the expected time of the Board's Final Written Decision.¹²

However, no trial date is currently scheduled, and the Final Pretrial Conference is scheduled for September 3, 2025, which means that actual trial is expected to occur

¹² Petitioner expects a notice of accorded filing date for this petition to be in March 2025, which means a Final Written Decision is expected sometime around September 2025.

after the time of the Board’s Final Written Decision. *See* EX1018, 5. This factor favors institution, or at a minimum is neutral.

3. Investment In Parallel Proceeding

The co-pending litigation is in its early stages, and the investment in it has been minimal. *See* EX1018. The parties have not exchanged preliminary positions on claim construction, and discovery has just begun. *See PEAG LLC v. Varta Microbattery GmbH*, IPR2020-01214, Paper 8, 17. Further, the Markman hearing is not scheduled until September 4, 2024, which is after the expected institution decision date by the Board. *See* EX1018, 2. This factor favors institution.

4. Overlapping Issues With The Parallel Proceeding

Petitioner stipulates that if the IPR is instituted, Petitioner will not pursue the same grounds in the district court litigation. *Sand Revolution II LLC v. Continental Intermodal Group – Trucking LLC*, IPR2019-01393, Paper 24 at 7 (informative). This factor favors institution.

5. Identity Of Parties

Petitioner is the defendant in the litigation. This factor should not be a basis for denying institution.

6. Other Circumstances, Including The Merits

“[T]he PTAB will not deny institution of an IPR or PGR under *Fintiv* (i) when a petition presents compelling evidence of unpatentability.” Memorandum,

“Interim Procedure for Discretionary Denials in AIA Post-Grant Proceedings with Parallel District Court Litigation,” 9 (June 21, 2022). Here, the evidence of unpatentability is compelling, and thus the PTAB should not deny institution under *Fintiv*. This factor favors institution.

Accordingly, *Fintiv* factors favor institution.

C. General Plastic Factors Favor Institution

The '862 patent has not been challenged in any prior IPR petition, so none of the *General Plastic* factors apply to this Petition and favor institution.

XII. Conclusion

Petitioner respectfully requests that the Board institute *inter partes* review, hold the challenged claims unpatentable, and cancel the challenged claims.

Dated: February 29, 2024

Respectfully submitted,

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CERTIFICATION UNDER 37 C.F.R. § 42.24(d)

I hereby certify that this Petition for *Inter Partes* Review of U.S. Patent No. 9,138,862 has, excluding the portions exempted under 37 C.F.R. § 42.24(a), 13,742 words as counted by the word-processing system used to prepare this document, in compliance with 37 C.F.R. § 42.24(d).

Dated: February 29, 2024

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CERTIFICATE OF SERVICE

Under 37 C.F.R. §§ 42.6(e) and 42.126, the undersigned certifies that on February 29, 2024, complete copies of the foregoing and any accompanying exhibits were caused to be served by sending them via Federal Express Priority Overnight shipping, which is at least as fast and reliable as U.S. Priority Mail Express, to the correspondence address of record for U.S. Patent No. 9,138,862 as indicated in Patent Center:

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Dated: February 29, 2024

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